State of Illinois
Illinois Department of Natural Resources

Fox River

WILLIAM G. STRATTON LOCK & DAM

Winter Drawdown Analysis

Illinois Department of Natural Resources

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DRAFT

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INTRODUCTION

Starting November 1 of each year the summer pool level in the Chain of Lakes is lowered 1.5 feet, from a stage of 737.0 at Fox Lake to a stage of 735.5 at Fox Lake. This is referred to as winter drawdown. The drawdown increases the storage available for springtime snow melt events and for cold weather flow reductions to prevent ice jam flooding. As part of the continuing effort to improve operations at the Stratton Lock & Dam, this analysis was conducted to re-analyze the hydraulic and hydrologic benefits of winter drawdown on the Fox River and Chain of Lakes.

The majority of the flooding events in the Fox watershed occur in the March, April, May (spring) time period. An analysis of the Algonquin stream gaging station (1916-2010) shows that of the 145 storm events since 1916 that have been greater than the two year event (3270 cfs) or the annual peak event if less than two year event, 75 have occurred in March and April. The storage provided by winter drawdown helps minimize flooding throughout the region when the snow melts with a rain event.

Adding to the flooding problems in winter is the potential for ice jams. When degree freezing days (the accumulation of average daily temperatures below freezing) reach 60, frazil ice forms in the river. The frazile ice collects on obstructions in the water until it blocks most of the capacity of the Fox River forming an ice jam. With ice jams flood stage can be reached at a flow of 1100 cfs as compared to a flow of 4000 cfs for open water flooding conditions. Outflows at Stratton Dam need to be reduced to 1100 cfs to minimize flooding when ice jams occur. If inflows into the system are greater than 1100 cfs during the reduced outflow period, the flood storage created by winter drawdown is utilized to reduce the risk of ice jam flooding downstream.

Inflows into the Chain of Lakes have been generally above average since August 2007. Several winter high water events have occurred in the last 3 years which reinforced the benefits of winter drawdown. These events were mid-winter snowmelt events with rain, i.e. a couple of days with above freezing temperatures and rain. When the cold temperatures return, flows are well above the 1100 cfs which can cause ice jam flooding. The potential for ice jam flooding has become more prevalent in the last few years due to higher flows and greater number of below normal temperature periods. Since 1994 conditions have been favorable for ice jam development 22 times during the winter drawdown period.

IMPACTS OF WINTER DRAWDOWN

Concerns have been raised about the environmental impacts of winter drawdown on the aquatic life in the Chain of Lakes and near the shoreline. The Water Level Fluctuation Work Group (WLFWG), convened by the Fox River Chain-O-Lakes Special Area Management Plan (SAMP), listed negative impacts to fish, wildlife, recreation, physical structures, natural processes and aesthetics in their final report issued in October 1991. Lowering the water levels each winter exposes shoreline and flats that were previously under water. Ice that accumulates on the lakes can cause damage to shoreline structures as the water level fluctuates up and down.

The following environmental impacts are taken from the paper *Summary of Ecological Impacts of the Fox River/Chain O'Lakes Winter Drawdown* compiled by Tim Vuglar (2000) and edited by Jeff Mengler (2005).

Impacts to Habitat and Natural Areas

During winter drawdown Grass Lake can freeze to the bottom. This freezing eliminates habitat for the muskrat. Winter drawdown has caused a decline in the hemi-marsh. With the freeze/ thaw cycle of wetland soils exposed by the lower lake levels, large pieces of the marsh can break off and float away.

Impacts to Fish

The lower water levels increase the storage by approximately 13,000 acre-ft for flood control but reduce the habitat for overwintering fish. Approximately 1800 acres of near-shore lake bottom and littoral zone are exposed, potentially killing off the benthic invertebrates in the littoral zone, which are a food source for the fishery. Extension of winter drawdown into the spring reduces spawning habitat. Lack of high spring water levels during the breeding cycle may interfere with spawning behavior of certain species.

However, our examination of the Fox Lake gage record shows that for the time period 1994-2011, winter drawdown did not affect spawning. Normal pool was reached in March in most years. During 8 years the stage at Fox Lake fell below normal pool level for 4 to 10 days after normal pool was reestablished at the completion of winter drawdown. During 2002 and 2005, summer pool was achieved April 11 and April 17 instead of April 1because these years were drought years and levels were raised slowly.

Impacts to Wildlife

Exposure of substrate through winter drawdown reduces invertebrate population. Aquatic invertebrate constitute a major food source for dabbling ducks. (Vuglar 2000). Muskrats require 3' of water depth over winter so winter drawdown reduces their habitat. Exposure to freezing of near shoreline lake bottom and wetland soils reduces habitat for hibernation of turtles, toads, frogs, and salamander.

Impacts to Recreation

Waterfowl hunting is affected in the second half of duck season as the lakes are lowered making it difficult for hunters to access blinds. Pool fluctuations within the Chain of Lakes during winter conditions can also cause impacts. Perched ice increases the hazards for recreational users of the Chain of Lakes. The void between the ice and water poses danger to ice fishermen and snowmobilers.

Impacts to Structures

There is concern about damage to seawalls, bulkheads and other structures and erosion of shorelines due to hydrostatic pressure in the adjacent ground when the lakes are lowered for winter drawdown. When ice forms at the level of the lakes and the lake level rises and falls, shoreline stress is created. This can cause structural damage to steel shoreline walls and to docks.

ALTERNATIVE ANALYSIS

With the increase in winter flooding due to above normal flows, ice jams, and mid-winter thaws, there have been inquires from residents along the river about increasing the winter drawdown operation. There have also been requests to reduce or modify the winter drawdown due to ecological and recreational concerns. Scenarios modeled in response to these various concerns include increasing winter drawdown from 1.5 feet to 2.0 feet, keeping the gates at Stratton Dam completely open during the winter, and total elimination of winter drawdown. The Fox River Full Equations model (FEQ), which is a one-dimensional unsteady flow hydraulic model, was used to compare the historic conditions with these alternative conditions.

For each winter/spring time period of November through March for the years 2005-2006 and 2007-2008, three alternatives for winter drawdown were examined. These include:

- Alternative 1- increasing winter drawdown from the current 1.5 ft to 2.0 ft,
- Alternative 2- keeping the sluice gates at Stratton Dam completely open for the November through March time period, and
- Alternative 3- eliminating winter drawdown and operating the gates according to historic operations during the flood event(s).

In addition to the two long term analysis of 2005-2006 and 2007-2008 four single snow melt events that occurred in 1960, 1974, 1979, and 1982 were modeled to analyze changes to the winter drawdown operation. The alternatives investigated were:

- Alternative 1- increasing winter drawdown amount from the current 1.5 ft to 2.0 ft,
- Alternative 2- keeping the sluice gates at Stratton Dam completely open
- Alternative 3- eliminating winter drawdown and operating the gates according to historic operations during the flood event, and
- Alternative 4- eliminating winter drawdown and operating the gates according to the operations manual.

These storms occurred before the operations manual was developed and published in 1989, so for Alternative 4 the gates were manipulated as if the plan was in place. Because these four events were single event storms and not a complete historical record from November through March Alternative 2 could not be analyzed for the complete winter drawdown time period. These storms also occurred before the installation of the hinged crest gate; therefore, the hinged crest gate elevation was set at the elevation of the spillway and not adjusted during the storm.

STORM MODELING

The time periods of 2005-2006 and 2007-2008 were selected since they represent time periods when flows were less than normal and also higher than normal. Measured inflows to the Chain of Lakes (Fox River at New Munster, WI and Nippersink Creek at Spring Grove, IL) were compared with the calculated median (normal) daily flow at those locations to determine whether those storm periods were below or above normal flow conditions. For

the below normal flow period, winter 2005 – 2006 was chosen and winter 2007- 2008 was chosen for the above normal flow period. Winter 2005-2006 was determined to be a low flow period because the inflows into the chain were consistently below the median inflow for much of the winter except for two small events in January and February and the spring warm-up in March. Winter 2007-2008 was determined to be an above normal flow period because the inflows into the chain were at or above the median inflow for the entire time frame. Figures 1 and 2 show the discharge hydrograph for the Fox River at New Munster, WI as compared to the Median flow for 2005-2006 and 2007-2008 respectively. Note that flows for some of the period of record are estimates because the stream gage was affected by ice; the river stage might have been higher than the open water stage.

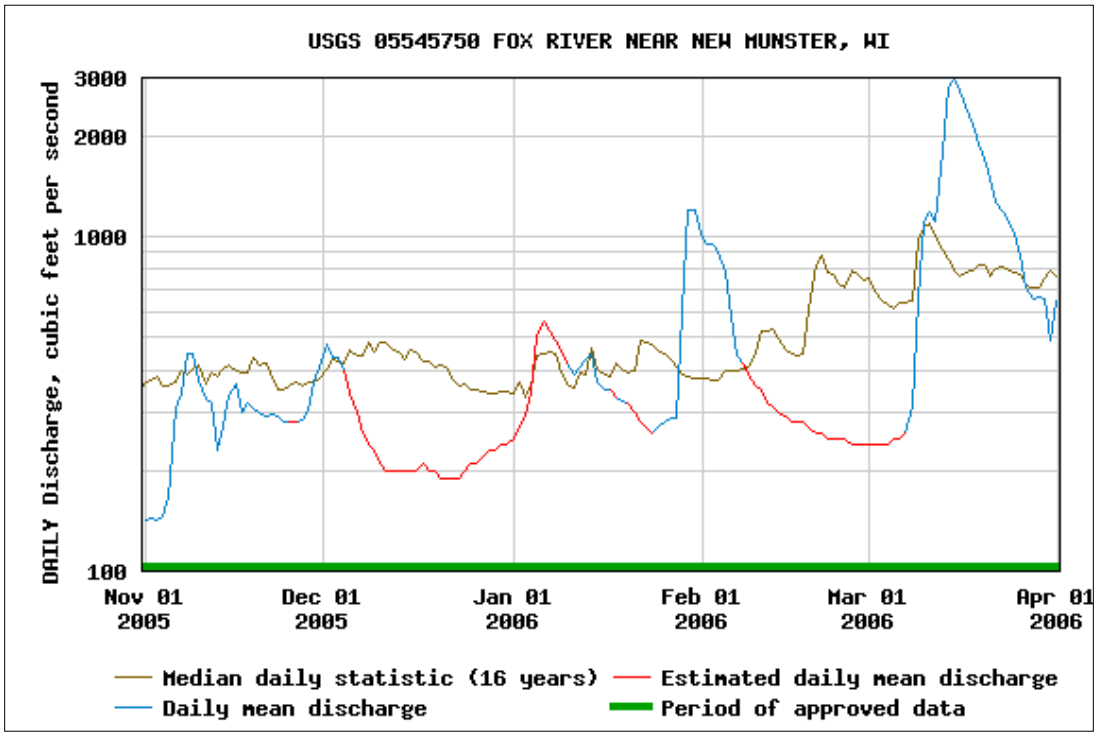

Figure 1 – 2005-2006 Fox River New Munster, WI Discharge

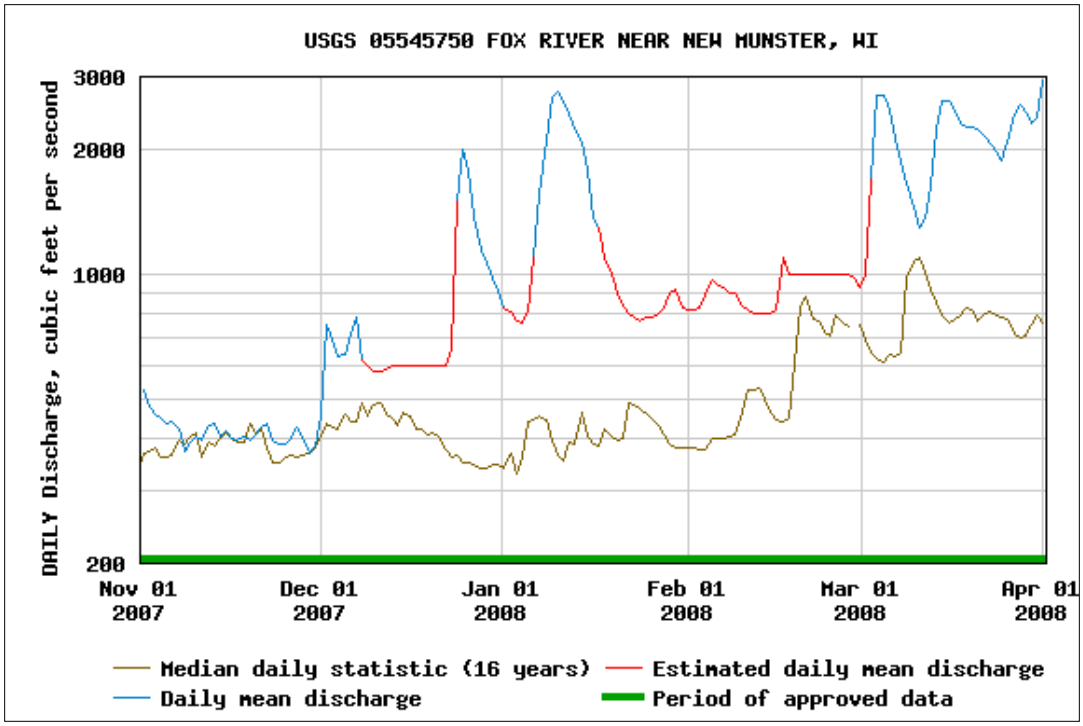

Figure 2– 2007-2008 Fox River New Munster, WI Discharge

Four other individual historic storm events were also used for analysis of changes to the winter drawdown plan: 1960, 1974, 1979 and 1982. These events were chosen because they were flood events that occurred during the winter/spring time and they were originally modeled in FEQ when the operation guide for Stratton Lock and Dam was developed in collaboration with the Illinois State Water Survey (ISWS). The ISWS Effects of Stratton Dam Operation on Flood Control Along the Fox River and Chain of Lakes, Contract Report 533, July 1992, provides more detail about the individual storms.

CALIBRATION

The two recent winter/spring periods (2005-2006 and 2007-2008) were used for calibration/verification of the FEQ model. The use of the snow melt events in 1960, 1974, 1979 and 1982 were not used for calibration of the FEQ model since they were short duration events.

Inflow hydrographs for the FEQ model were gathered from historic gage records for the Fox River New Munster (drainage area 811 sq miles) and Nippersink Creek (drainage area 192 sq miles). A Fox River watershed hydrologic model generated the hydrographs for the other ungaged tributaries (drainage area 247 sq miles). Initial modeling efforts showed that computed peak stages for events in February and March 2005 were high. The hydrologic model is sensitive to temperature so it did not match peak flows and volume of runoff well for the mid-winter snow melt events. While the snow melts at temperatures above 32°F in the real world, the hydrologic model needs temperatures closer to 40° F. Without melting the snow in the middle of winter as occured historically, the model has more runoff volume during the March snow melt event. To calibrate the model, hydrographs developed from

the hydrologic model (which are only used for the ungaged inflows to the Chain of Lakes) were reduced by 25% and 50% to help reduce the computed peak stages. Results from the 2005-2006 modeling can be seen in Figure 3. Both procedures resulted in the desired effect, lower peak stages. However, the 50% hydrograph reduction effort reduced stages too much overall. The computed peaks are closer to the gage record, but in the months of January and February the computed stage is much lower than the actual stages. The 25% hydrograph reduction effort produced results that were closer to the gage record. Therefore the FEQ model with the local tributary inflow hydrographs reduced 25% was used for the drawdown analysis. The 25% reduction was also used for the 2007-2008 storm period to maintain consistency between the models. Figure 4 shows the calibration results from the 2007-2008 modeling.

Table 1 lists the difference between the gage record and the computed stage for locations along the Fox River for the 2005-2006 period. Computed stages are from the FEQ model with a 25% reduction in the ungaged tributary inflow hydrographs. Computed stages were 0.09 to 0.23 ft lower than gage results for the January 2006 event. For the modeled time period beginning in February 2006, computed stages were 0.04 to 0.1 ft lower than the actual stages for locations above Stratton Dam and 0.6 to 0.7 ft higher for locations downstream. For the March spring runoff event, computed stages were 0.3 to 0.85 ft higher than the gage records.

Table 2 lists the difference between the gage record and the computed stage for locations along the Fox River for the 2007-2008 period. Computed stages are from the FEQ model with a 25% reduction in the tributary inflow hydrographs. For the modeled time period ending in December 2007, computed stages were 0.22 to 0.52 ft higher than gage results for the small event. In January, computed stages were ranged from 0.17 to 0.19 ft higher for locations upstream of Stratton Dam and 0.57 to 0.61 ft higher for locations downstream. In March, most locations were lower than the gage record by approximately 0.04 to 0.64 ft.

While the modeled results of the 2005-2006 and 2007-2008 storm periods are not perfect matches with the gage results, the modeled results are within the ranges of events that are reasonably expected to occur. The use of these two storm periods as modeled is appropriate for determining impacts of alternative drawdown scenarios.

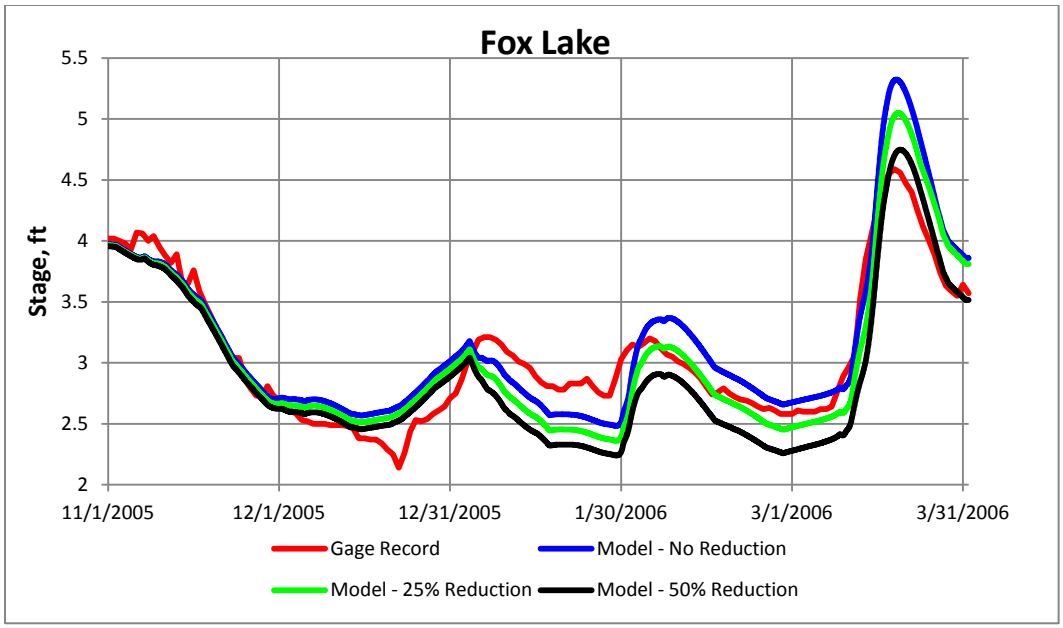

Figure 3- 2005-2006 Calibration

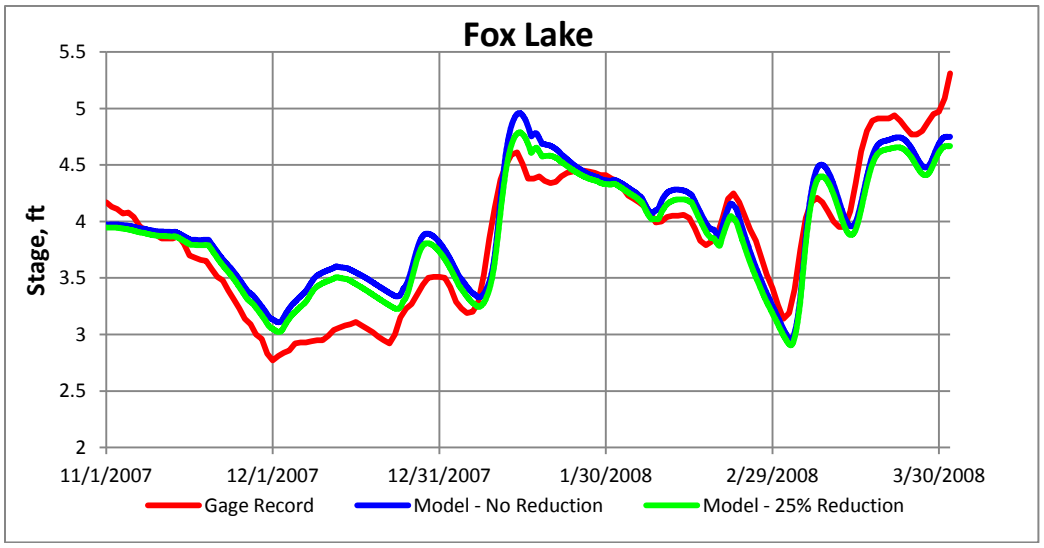

Figure 4 – 2007-2008 Calibration

Table 1 - 2005-2006 Calibration - Below Normal Flow - FEQ Model = 25% Inflow Reduction

	Computed Water Surface Elevation								
	Peak on January 5, 2006			Peak on February 4, 2006			Peak on March 20, 2006		
Location	Gage	FEQ Model	Difference	Gage	FEQ Model	Difference	Gage	FEQ Model	Difference
Fox Lake	736.19	735.96	-0.23	736.20	736.10	-0.10	737.56	738.04	0.48
Johnsburg	736.00	735.84	-0.16	735.98	735.92	-0.06	737.32	737.67	0.35
US Stratton Dam	735.64	735.55	-0.09	735.57	735.53	-0.04	736.56	736.89	0.33
DS Stratton Dam	732.25	732.13	-0.12	731.99	732.61	0.62	733.53	734.38	0.85
US Algonquin Dam	731.41	731.27	-0.14	730.83	731.52	0.69	731.09	731.49	0.40
DS Algonquin Dam	727.12	726.96	-0.16	727.51	727.64	0.13	729.45	729.45	0.00

Table 2 - 2007-2008 Calibration – Above Normal Flow - FEQ Model = 25% Inflow Reduction

	Computed Water Surface Elevation								
	Peak on December 29, 2007			Peak on January 14, 2008			Peak on March 22, 2008		
Location	Gage	Model	Difference	Gage	Model	Difference	Gage	Model	Difference
Fox Lake	736.50	736.81	0.31	737.61	737.78	0.17	737.94	737.65	-0.29
Johnsburg	736.29	736.61	0.32	737.09	737.28	0.19	737.47	737.12	-0.35
US Stratton Dam	735.86	736.16	0.30	735.71	735.90	0.19	735.87	735.39	-0.48
DS Stratton Dam	732.51	733.03	0.52	734.16	734.73	0.57	734.70	734.66	-0.04
US Algonquin Dam	731.38	731.60	0.22	731.30	731.91	0.61	731.43	731.64	0.21
DS Algonquin Dam	727.89	727.84	-0.05	729.79	729.80	0.01	730.38	729.74	-0.64

2005-2006 – Below Normal Flows Time Period

Alternative 1 - Increasing Winter Drawdown

The goal of Alternative 1 was to reduce flood stages along the Fox River by providing more storage of flood flows in the Chain of Lakes during the winter months. Lowering the winter pool elevation an extra 0.5 feet would increase the available storage in the Chain of Lakes by 3,250 acre-feet. To simulate lowering the pool an extra 0.5 feet, the sluice gates at Stratton Dam were held open longer in the Alternative 1 conditions model before being adjusted to equalize inflows and outflows. This method maintained the same drawdown rate as the historic condition, and the desired stage was reached around December 10 instead of the beginning of the month. During the modeling of the three flood events in the 2005-2006 time period, the sluice gates at Stratton Dam were opened in a similar manner as historic condition. This methodology measured the impact of the larger drawdown rather than a different gate operation plan. As each flood event in the simulation period ended the gates in the model were kept open for a longer time period to facilitate returning to the lower winter drawdown conditions. Except as noted above the hinged crest gates at Stratton Dam and Algonquin Dam were operated the same in the computer model as was done in the field.

Results of the modeling show that for the small event in the beginning of January, the reduction in stage in the lakes and upstream of Stratton Dam would have been 0.4 feet. Stage reductions are smaller, 0.05 to 0.14 feet, as you travel downstream of Stratton Dam. For the other two events that occurred in early February and mid-March, the reduction in stage would have been 0.06 to 0.19 feet. Downstream of Stratton Dam, increasing winter drawdown would reduce stages approximately 0.04 to 0.13 feet. These reductions in stages downstream of Stratton Dam are only moderate because the extra storage provided by the lowered winter pool elevation is filled up before the flood peak reached the Chain of Lakes.

Alternative 2 - Gates Fully Open

This alternative could not be modeled for this time period. The FEQ model would “dry out” and computations would stop due to the low flows. Due to the complexity of the unsteady flow equations, the FEQ model has difficulty converging on a water surface elevation when there is minimal flow in the channel. In a “real world” situation with below normal flows, the river would continue to flow at a minimal level and the lakes would probably be drawdown below a level suitable for winter habitat.

Alternative 3 - Eliminating Winter Drawdown

The settings of the gates at Stratton Dam were modeled by making adjustments so that inflow equal outflow during normal flow periods to maintain a Fox Lake stage of 4.0. When flows increased above 1800 cfs, gates were adjusted according to historic operations. With the elimination of winter drawdown, comparisons of the two small events in January and February were not meaningful upstream of Stratton Dam as the lakes did not reach summer pool historically. Therefore Alternative 3 shows an increase in stage upstream of Stratton Dam due to the higher pool level for January and February events. Downstream of Stratton Dam, the peak water surface for the January event was reduced because the

lakes did not have to be dewatered back down to winter pool elevation and outflows were scaled back to normal operations sooner. In the modeled time period ending in February 2006, peak water surfaces downstream of Stratton Dam ranged from 0.13 to 0.43 feet higher for Alternative 3. For the spring melt event in March 2006, peak water surfaces would have been approximately 0.3 feet higher in the Chain of Lakes and along the river for Alternative 3 than for historic conditions. Figures 5-7 are stage hydrographs for the historic operations, Alternative 1, and Alternative 3 for Fox Lake, Stratton Tailwater, and Richardson Subdivision respectively; Figure 7 does not account for potential ice jam flooding by reducing flows when 60 degree freezing days are accumulated. Tables 4, 5 and 6 list computed stages and the comparison to the current winter drawdown plan (1.5 feet) for locations along the Fox River.

Damage Analysis

Peak stages for each alternative were compared to first floor elevations for 4282 structures along the Fox River and Chain of Lakes. Table 3 lists the number of flooded structures for each alternative and the number of structures impacted by flooding within 3 feet of the first floor during the March snowmelt event. The analysis within 3 feet of the first floor shows the impacts to crawlspaces, garages, septic fields, and access to the home.

When flows are below normal, as was the case for the winter of 2005-2006, winter drawdown does appear to play a role in reducing flood damages. Increasing the amount of drawdown would provide a few benefits, but eliminating winter drawdown would increase stages and flood damages in the lakes and river.

Table 3 – 2005-2006 Flood Damages

	Normal Operations	Alt. 1 2' Winter Drawdown	Structures w/ flooding eliminated	Alt. 3 No Winter Drawdown	Additional Structures w/ flooding
Structures with water above the first floor elevation					
Above Stratton Dam	12	12	0	14	2
Below Stratton Dam	1	1	0	1	0
Structures with water within 3' of the first floor elevation					
Above Stratton Dam	90	81	9	158	68
Below Stratton Dam	144	135	9	195	51

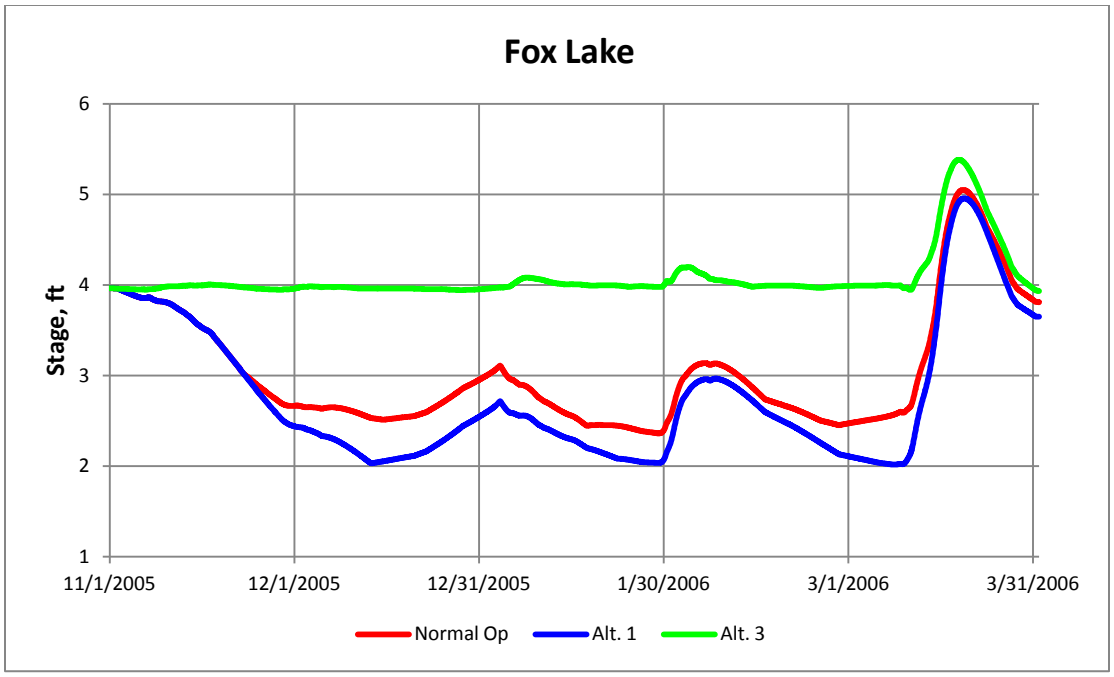

Figure 5 - 2005-2006 - Drawdown Comparison at Fox Lake

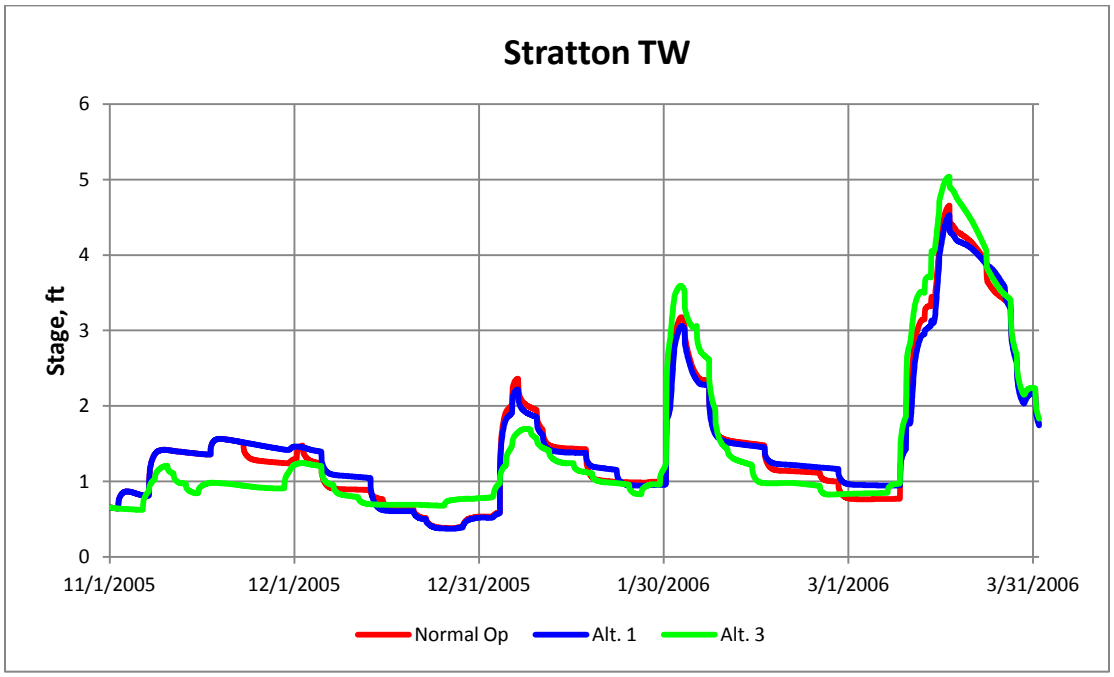

Figure 6 - 2005-2006 - Drawdown Comparison at Stratton Tailwater

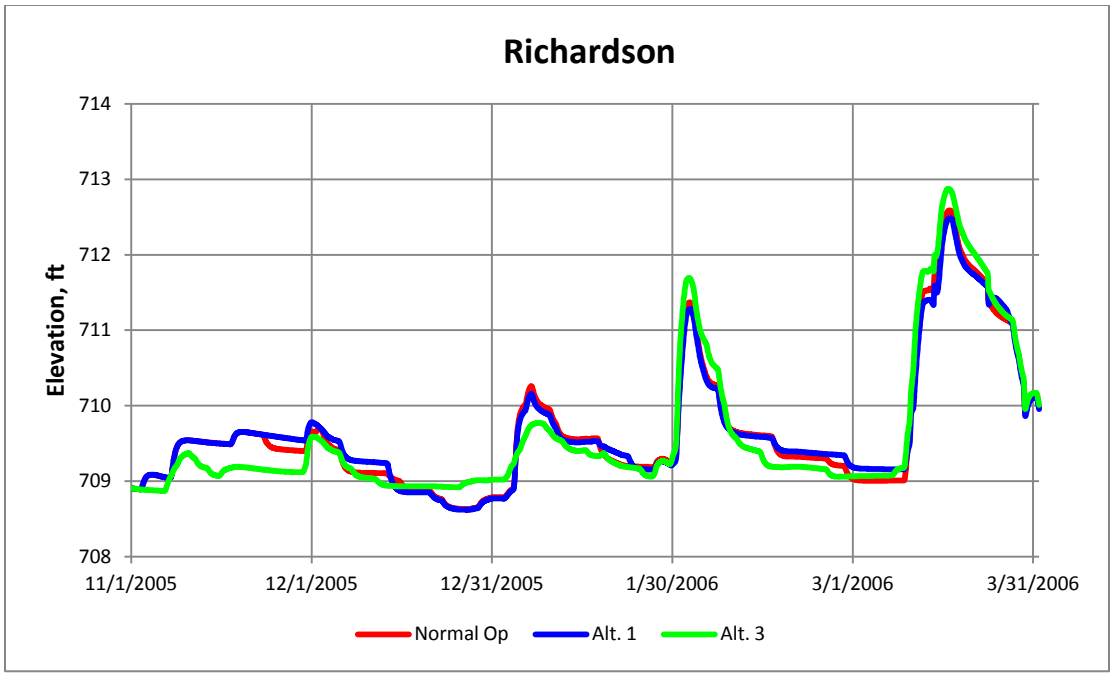

Figure 7 - 2005-2006 - Drawdown Comparison at Richardson Subdivision

Table 4 - Peak Water Surface Comparison January 2006

Location	Computed Water Surface Elevation				
	January 3-4, 2006				
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No Winter Drawdown	Difference
173rd St	736.31	736.04	-0.27	737.23	0.92
Channel Lake	736.12	735.72	-0.39	737.09	0.98
Fox Lake	736.11	735.72	-0.39	737.08	0.97
Nippersink Creek	736.44	736.19	-0.25	737.17	0.73
Nippersink Lake	736.11	735.71	-0.40	737.08	0.97
Johnsburg	736.10	735.71	-0.40	737.04	0.94
Route 120	736.10	735.70	-0.40	737.00	0.90
US Stratton Dam	736.10	735.70	-0.40	736.98	0.88
DS Stratton Dam	732.51	732.37	-0.14	731.85	-0.67
Route 176	732.21	732.09	-0.12	731.65	-0.56
Rawson Bridge	731.91	731.81	-0.10	731.44	-0.47
Route 14	731.58	731.51	-0.07	731.25	-0.33
US Algonquin Dam	731.41	731.36	-0.05	731.16	-0.25
DS Algonquin Dam	727.35	727.21	-0.14	726.66	-0.68
US Carpentersville Dam	721.74	721.69	-0.04	721.50	-0.23
DS Carpentersville Dam	715.18	715.11	-0.07	714.86	-0.32
Main St	711.91	711.77	-0.14	711.22	-0.69
Richardson Subdivision	710.26	710.16	-0.10	709.77	-0.49
NW Tollway	709.62	709.56	-0.06	709.32	-0.30
South Elgin	700.68	700.63	-0.05	700.45	-0.23

Table 5 – Peak Water Surface Comparison February 2006

Location	Computed Water Surface Elevation				
	February 5-7, 2006				
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No Winter Drawdown	Difference
173rd St	736.90	736.81	-0.10	737.61	0.71
Channel Lake	736.18	736.01	-0.17	737.22	1.04
Fox Lake	736.14	735.97	-0.17	737.20	1.06
Nippersink Creek	736.37	736.23	-0.14	737.33	0.96
Nippersink Lake	736.14	735.97	-0.17	737.20	1.06
Johnsburg	736.07	735.90	-0.17	737.08	1.01
Route 120	736.00	735.82	-0.18	736.99	1.00
US Stratton Dam	735.95	735.76	-0.19	736.97	1.02
DS Stratton Dam	733.33	733.21	-0.12	733.74	0.42
Route 176	733.04	732.94	-0.10	733.40	0.36
Rawson Bridge	732.76	732.67	-0.09	733.06	0.30
Route 14	732.26	732.19	-0.07	732.52	0.26
US Algonquin Dam	731.89	731.85	-0.04	732.06	0.17
DS Algonquin Dam	728.55	728.43	-0.11	728.98	0.43
US Carpentersville Dam	722.21	722.17	-0.04	722.36	0.15
DS Carpentersville Dam	715.89	715.82	-0.07	716.18	0.29
Main St	713.28	713.17	-0.12	713.71	0.43
Richardson Subdivision	711.37	711.28	-0.09	711.69	0.32
NW Tollway	710.51	710.45	-0.06	710.77	0.25
South Elgin	701.35	701.32	-0.04	701.48	0.13

Table 6 - Peak Water Surface Comparison March 2006

Location	Computed Water Surface Elevations March 19-21, 2006 Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No Winter Drawdown	Difference
173rd St	738.93	738.88	-0.05	739.13	0.20
Channel Lake	738.09	738.00	-0.09	738.42	0.33
Fox Lake	738.05	737.96	-0.09	738.38	0.33
Nippersink Creek	738.15	738.09	-0.06	738.44	0.29
Nippersink Lake	738.05	737.95	-0.09	738.38	0.33
Johnsburg	737.68	737.59	-0.09	737.99	0.31
Route 120	737.27	737.19	-0.08	737.56	0.29
US Stratton Dam	736.89	736.82	-0.08	737.15	0.26
DS Stratton Dam	734.81	734.68	-0.13	735.19	0.38
Route 176	734.27	734.15	-0.12	734.63	0.36
Rawson Bridge	733.78	733.66	-0.12	734.12	0.35
Route 14	732.84	732.74	-0.10	733.14	0.29
US Algonquin Dam	731.86	731.80	-0.06	732.04	0.18
DS Algonquin Dam	730.20	730.07	-0.13	730.59	0.39
US Carpentersville Dam	722.82	722.78	-0.05	722.97	0.15
DS Carpentersville Dam	717.11	717.00	-0.12	717.44	0.33
Main St	714.86	714.74	-0.13	715.22	0.36
Richardson Subdivision	712.59	712.49	-0.10	712.87	0.29
NW Tollway	711.48	711.40	-0.09	711.72	0.24
South Elgin	701.92	701.88	-0.04	702.03	0.11

2007-2008 – Above Normal Flows Time Period

Alternative 1 - Increased Winter Drawdown

To simulate lowering the pool an extra 0.5 feet, the sluice gates at Stratton Dam were held open longer in the modified conditions model. This method maintained the same drawdown rate as the historic condition and the desired stage was reached around December 20 instead of the beginning of the month. Once increased flows started at the end of December, the lakes were not able to be maintained at winter pool elevation due to concerns about flooding that could occur due to ice jams. The number of degree freezing days exceeded 60 and the operation guide calls for reducing discharges to 1100 cfs to reduce ice jam flooding. Discharges from Stratton Dam were reduced to minimize the generation of ice both historically and in the modeling. The settings for the sluice gates at Stratton Dam were set at the same settings as was recorded in the historic record. The hinged crest gates at Stratton Dam and Algonquin Dam were operated similar to historic conditions also.

Results of the computer modeling of Alternative 1 show that for the event in January 2008, the extra storage provided by the larger winter drawdown would be filled before the peak discharge arrives. Stage reductions in the lakes and downstream of Stratton Dam would be in the range of 0.03 to 0.06 feet. In the river reach above Stratton Dam, the stage reduction would be in the range of 0.03 to 0.19 feet. The stage reductions for the March event are negligible, 0.01 feet, and are probably more related to computational rounding in the FEQ model.

Alternative 2 - Gates Fully Open

The computer simulation of this alternative was accomplished by adjusting the sluice gates at Stratton Dam 0.2 feet each day up to an opening of 2 feet, then 0.25 feet each day up to an opening of 4.0 feet, and then 0.5 feet each day thereafter until the total opening of 7.0 feet was achieved. The slow opening pattern allowed the gate opening to be modeled without creating instability issues in the FEQ model. In the model the hinged crest gates at Algonquin and Stratton were operated the same as historical conditions. In the simulated time period for January 2008 the stage reductions between Alternative 2 and historic conditions in the lakes and on the Fox River reach upstream of Stratton Dam were around 0.1’. Downstream of Stratton Dam the reduction of water surface elevation was similar to upstream of Stratton ranging from 0.05’ to 0.11’. Alternative 2 minimally lowered water surfaces for the spring event in March approximately 0.04 feet throughout the region as compared to historic conditions.

Alternative 3 - Eliminating winter drawdown

Alternative 3 evaluates the elimination of winter drawdown. The minimum stage of Fox Lake is held to 4.0 feet. The sluice and hinged crest gates are operated similar to historic conditions during the high water events. However, the gates are closed sooner after the event passes to keep the Chain of Lakes at summer pool. During the January 2008 event, stages increases between Alternative 3 and historic conditions range from 0.14 feet to 0.40 feet in the Chain of Lakes and along the Fox River. During the March 2008 the increase in water surface elevations are similar to the January event. During the later part of February 2008 historically, the Chain of Lakes was lowered to a stage of 3.0 on Fox Lake during a warmer period when ice jams were not a concern.

Damage Analysis

Reductions in peak water surface of less than 0.1 feet would result from increasing the winter drawdown from 1.5 feet to 2 feet or opening the gates wide to pass as much flow as possible. Eliminating winter drawdown would result in increased peak water surface elevations by 0.14 feet to 0.4 feet. These results were seen in both the mid-January event and the March event.

Table 7 lists the number of flooded structures for each alternative. The analysis of structures that would be flooded during the winter 2008 season shows that the number of structures with flooding on their first floor is not impacted by any of the alternatives. However, *Alternative* 1 could eliminate the impacts of flooding around 18 structures. Alternative 2 could eliminate the impacts of flooding around 22 structures. Alternative 3 could increase flooding around 36 structures.

Table 7 – 2007-2008 Flood Damages

	Normal Operations	Alt. 1 2' Winter Drawdown	Structures w/ flooding eliminated	Alt. 2 Sluice Gates Fully open	Additional Structures w/ flooding	Alt. 3 No Winter Drawdown	Additional Structures w/ flooding
Structure with water above the first floor elevation							
Above Stratton Dam	12	12	0	12	0	12	0
Below Stratton Dam	1	1	0	1	0	1	0
Structure with water within 3' of the first floor elevation							
Above Stratton Dam	69	58	11	54	15	83	12
Below Stratton Dam	117	110	7	110	7	141	24

Figures 8-10 are stage hydrographs for Fox Lake, Stratton Dam Tailwater, and Richardson Subdivision. Tables 8 and 9 list computed stages and the comparison to the current winter drawdown plan (1.5 feet) for locations along the Fox River.

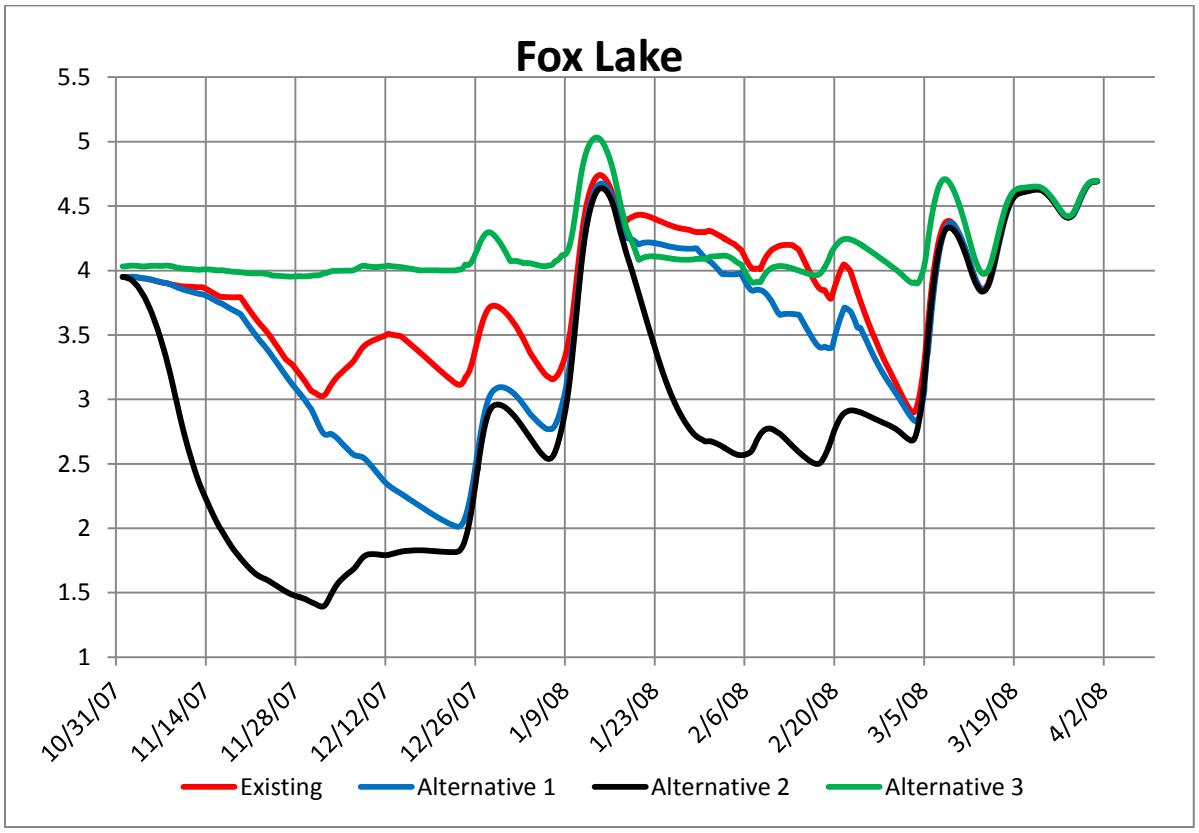

Figure 8 - 2007-2008 - Drawdown Comparison at Fox lake

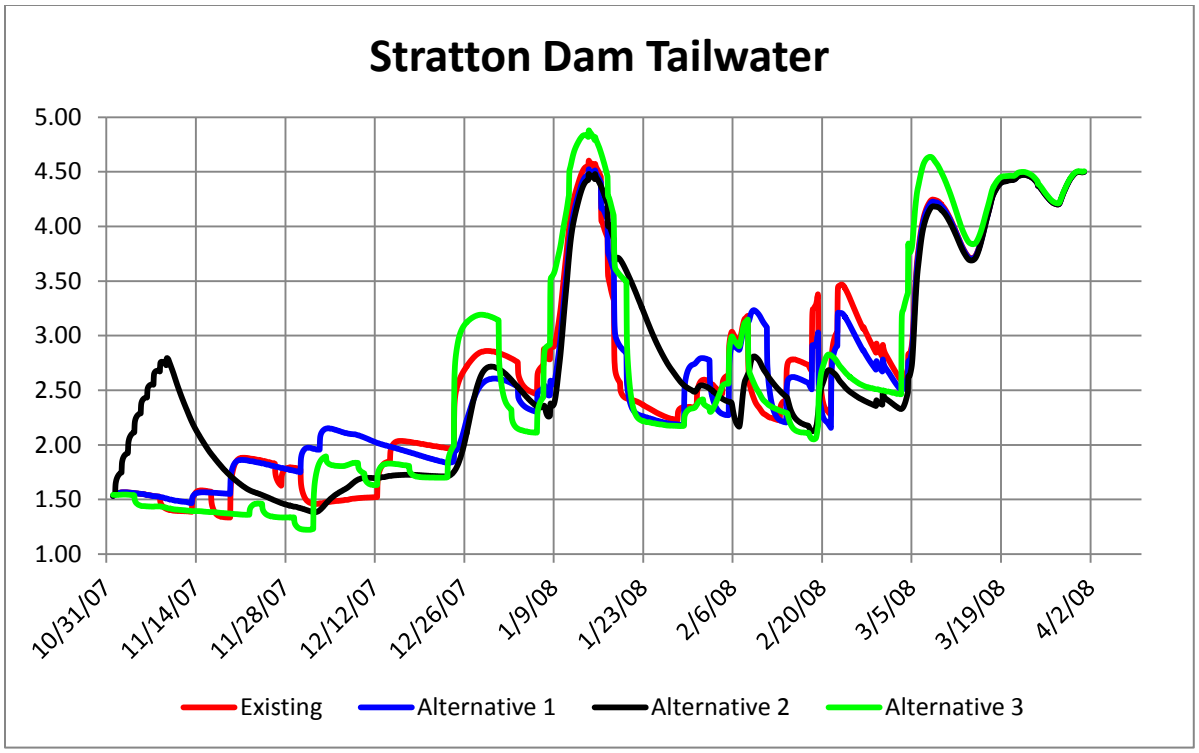

Figure 9 - 2007-2008 - Drawdown Comparison at Stratton Tailwater

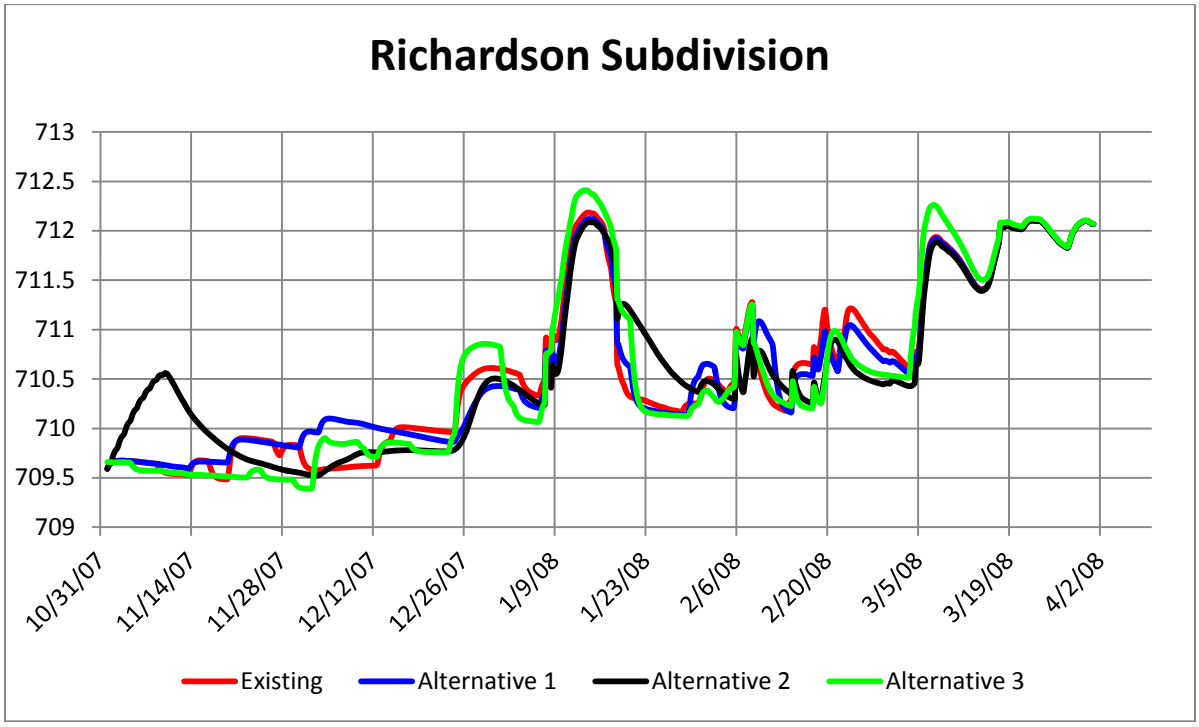

Figure 10 - 2007-2008 – Drawdown Comparison at Richardson Subdivision

Table 8 – Peak Water Surface Comparison January 2008

Location	Computed Water Surface Elevation January 14, 2008						
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 2 Sluice Gates Full Open	Difference	Alt. 3 No Winter Drawdown	Difference
173rd St [1]	738.88	738.85	-0.03	738.84	-0.04	739.02	0.14
Channel Lake	737.80	737.74	-0.06	737.70	-0.10	738.09	0.29
Fox Lake	737.74	737.68	-0.06	737.64	-0.10	738.03	0.29
Nippersink Lake	737.74	737.67	-0.07	737.63	-0.11	738.03	0.29
Johnsburg	737.28	737.16	-0.12	737.13	-0.15	737.52	0.24
Route 120	736.54	736.48	-0.06	736.45	-0.09	736.89	0.35
US Stratton Dam	735.73	735.54	-0.19	735.63	-0.10	736.13	0.40
DS Stratton Dam	734.73	734.67	-0.06	734.63	-0.10	734.98	0.25
Route 176	734.09	734.03	-0.06	733.99	-0.10	734.35	0.26
Rawson Bridge	733.52	733.45	-0.07	733.41	-0.11	733.77	0.25
Route 14	732.53	732.47	-0.06	732.44	-0.09	732.76	0.23
US Algonquin Dam	731.61	731.57	-0.04	731.56	-0.05	731.76	0.15
DS Algonquin Dam	729.82	729.75	-0.07	729.71	-0.11	730.12	0.30
US Carpentersville Dam	722.66	722.63	-0.03	722.61	-0.05	722.77	0.11
DS Carpentersville Dam	716.75	716.69	-0.06	716.66	-0.09	716.99	0.24
Main St	714.43	714.36	-0.07	714.32	-0.11	714.72	0.29
Richardson Subdivision	712.19	712.12	-0.07	712.09	-0.10	712.41	0.22
NW Tollway	711.06	711.01	-0.05	710.98	-0.08	711.25	0.19
South Elgin	701.57	701.54	-0.03	701.52	-0.05	701.68	0.11

1 - Peak on January 11, 2008

Table 9 – Peak Water Surface Comparison March 2008

Location	Computed Water Surface Elevation						
	March 7-8, 2008						
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 2 Sluice Gates Full Open	Difference	Alt. 3 No Winter Drawdown	Difference
173rd St	738.52	738.51	-0.01	738.49	-0.02	738.68	0.17
Channel Lake	737.45	737.43	-0.02	737.40	-0.03	737.77	0.34
Fox Lake	737.39	737.37	-0.02	737.33	-0.04	737.71	0.34
Nippersink Lake	737.38	737.36	-0.02	737.33	-0.03	737.70	0.34
Johnsburg	736.85	736.84	-0.01	736.80	-0.04	737.17	0.33
Route 120	736.07	736.05	-0.02	736.02	-0.03	736.40	0.35
US Stratton Dam	735.02	735.00	-0.02	734.96	-0.04	735.40	0.40
DS Stratton Dam	734.39	734.38	-0.01	734.33	-0.05	734.79	0.41
Route 176	733.91	733.78	-0.13	733.74	-0.04	734.17	0.39
Rawson Bridge	733.24	733.22	-0.02	733.19	-0.03	733.61	0.39
Route 14	732.33	732.32	-0.01	732.29	-0.03	732.65	0.33
US Algonquin Dam	731.56	731.55	-0.01	731.53	-0.02	731.76	0.21
DS Algonquin Dam	729.47	729.45	-0.02	729.40	-0.05	729.89	0.44
US Carpentersville Dam	722.52	722.52	0.00	722.49	-0.03	722.69	0.17
DS Carpentersville Dam	716.47	716.47	0.00	716.44	-0.03	716.81	0.34
Main St	714.10	714.08	-0.02	714.04	-0.04	714.51	0.43
Richardson Subdivision	711.94	711.92	-0.02	711.88	-0.04	712.26	0.34
NW Tollway	710.87	710.86	-0.01	710.82	-0.04	711.15	0.29
South Elgin	701.47	701.48	0.01	701.44	-0.04	701.63	0.15

April 1960 Flood Event

The four historic storm events that are simulated in the FEQ model differ from the 2005-2006 and 2007-2008 events in that they only represent one storm event and not the entire winter season. The event in April 1960 was considered one of the top two floods of record for the Fox River when the ISWS report was published. According to that report the main source of flooding was snowmelt and the spring thaw plus an additional 1.3 inches of rainfall. The peak flow on the Fox River near Wilmot, Wisconsin is the highest flow of record at 7520 cfs. The peak flow measured at the Fox River at Algonquin gage was 6610 cfs. This storm peak flow at Algonquin is very similar to the peak flows experience in the August 2007 flood event. This storm occurred before the hinged crest gates were constructed and before the Operation Guide had been developed. The operation plan for the sluice gates at Stratton Dam during this time period was to utilize as much storage in the Chain of Lakes as possible. The gates were opened to a setting of 2.4 feet.

Alternative 1 - Increased Winter Drawdown

Inspection of historic operations showed an attempt to lower the winter pool in March 1960 before inflows began to increase which limited the drawdown to 1 feet; the Fox Lake stage was 3.0 feet at the beginning of the flood event. For this alternative, the original drawdown rate in the beginning of March was maintained to lower the pool level further. At the time of the beginning of the storm event in late March, the pool level was reduced approximately 1.75 feet which is equivalent to a Fox Lake stage of 2.25 feet. The additional reduction of water levels in the Chain of Lakes would have lowered the peak stages along the entire river reach approximately 0.1 to 0.2 feet.

Alternative 2 – Gates Wide Open

Because of the short time period of the simulated storm the impacts of keeping the gates wide open for the entire winter drawdown period could not be analyzed.

Alternatives 3 and 4 - Eliminating winter drawdown

Alternative 3 eliminates the historic drawdown for this event while operating the sluice gates the same as historic conditions. Alternative 3 had the opposite effect on water surfaces as Alternative 1. Peak stages under Alternative 3 conditions would have increased approximately 0.1 to 0.2 feet along the entire reach.

Alternative 4 eliminates the historic drawdown for this event but operates the gate using the current Operation Guide. This alternative tries to show the benefits of a pro-active response to high water utilized in the Operation Guide. Under Alternative 4 conditions stages in the Chain of Lakes would have been reduced approximately 0.23 feet and stages at Stratton Dam would have been reduced 0.75 feet. Downstream of the dam stages would have increased an average 0.25 feet. If the current operation plan had been followed in 1960, flows downstream of Stratton Dam would have been greater. If the hinged crest gate at Algonquin Dam had been available during the 1960 storm event, no increase in stages on the Fox River between Stratton and Algonquin Dam would be seen.

Damage Analysis

Increasing winter drawdown would reduce peak stages up to 0.2 feet, while eliminating the drawdown would raise peak stages 0.15 feet on average. The pro-active gate approach even without a winter drawdown lowers river stages upstream of Stratton Dam.

Table 10 lists the number of flooded structures for each alternative. This storm event was the largest historic storm and would impact the most structures, 2491 structures currently in the floodplain. In terms of structures with flooding above the first floor elevation, 43 structures would be removed with increased winter drawdown verses an additional 50 structures added with winter drawdown eliminated. Figures 11-13 are stage hydrographs for Fox Lake, Stratton Tailwater, and Richardson Subdivision. Table 11 lists computed stages and compares the peak water surface elevations for locations along the Fox River from the historic operations to the Alternative conditions.

Table 10 – 1960 Flood Damages

	Normal Operations	Alt. 1 2' Winter Drawdown	Structures w/ flooding eliminated	Alt. 3 No WD – Normal Op.	Additional Structures w/ flooding	Alt. 4 No WD – Op. Guide	Structures w/ flooding eliminated
Structures with water above the first floor elevation							
Above Stratton Dam	171	145	26	195	24	104	67
Below Stratton Dam	124	107	17	150	26	168	44
Structure with water within 3' of the first floor elevation							
Above Stratton Dam	1795	1767	28	1831	36	1689	106
Below Stratton Dam	696	667	29	732	36	753	57

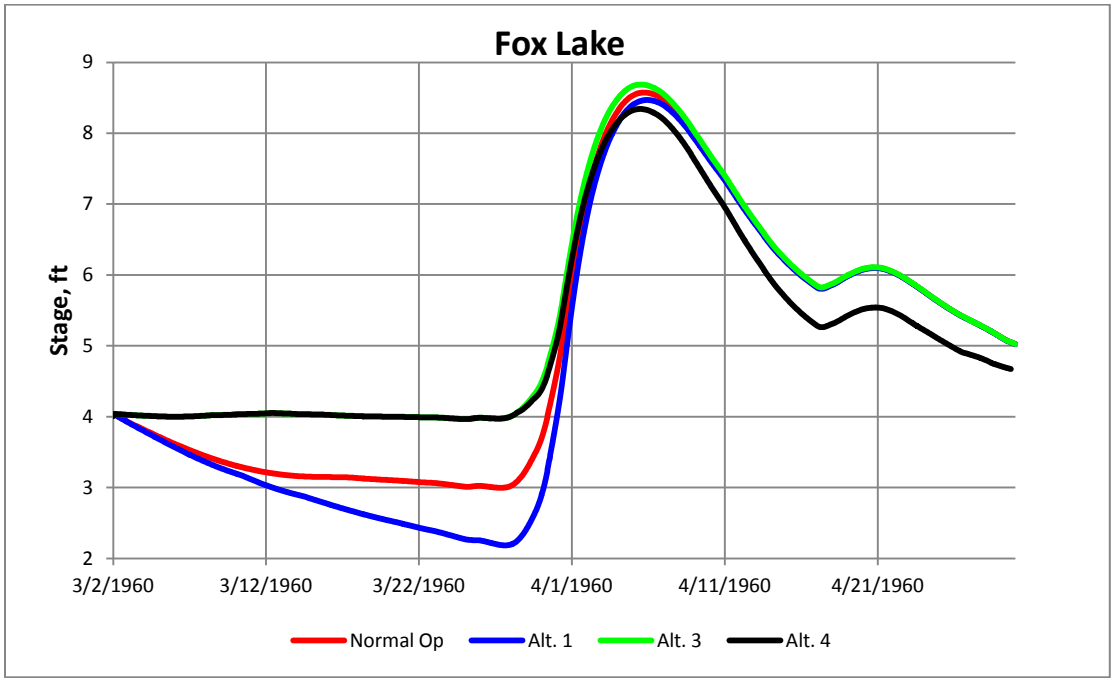

Figure 11 - 1960 - Drawdown Comparison at Fox Lake

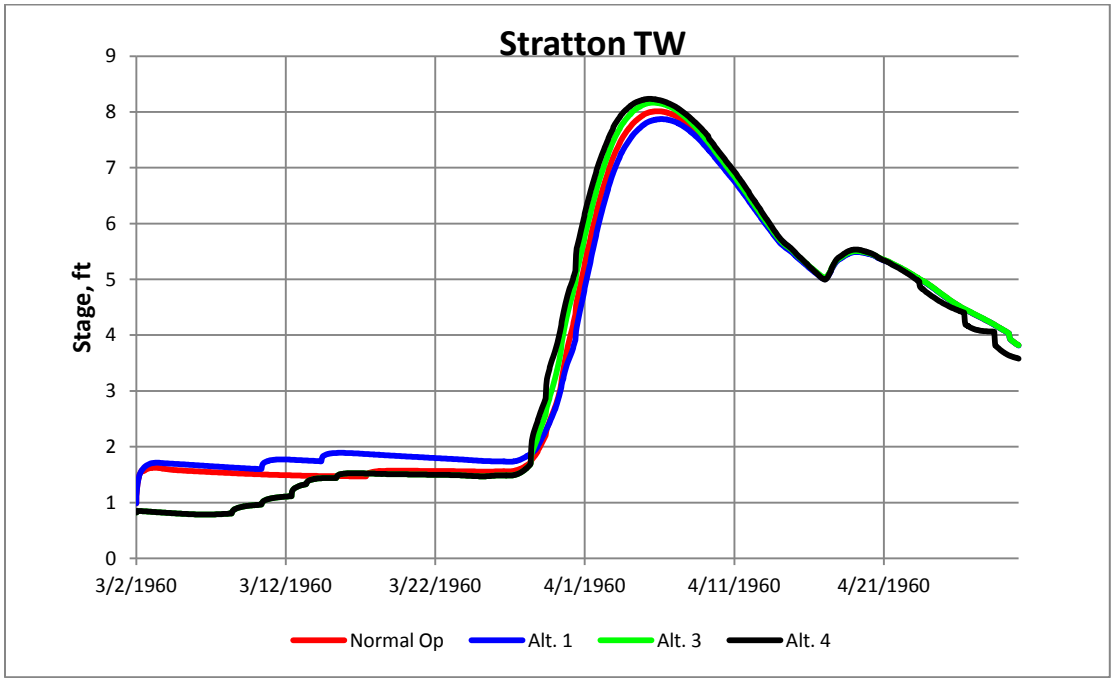

Figure 12 - 1960 - Drawdown Comparison at Stratton Tailwater

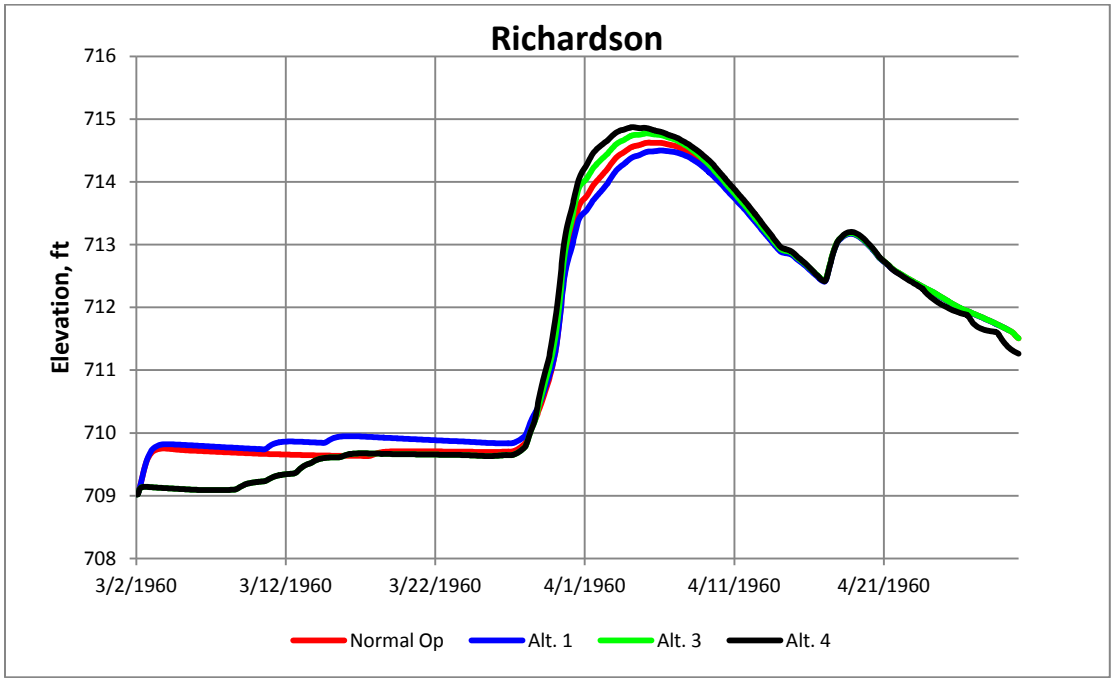

Figure 13 - 1960 - Drawdown Comparison at Richardson Subdivision

Table 11 – Peak Water Surface Comparison April 1960

Location	Computed Water Surface Elevation 4/5/1960						
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No WD – Normal Op.	Difference	Alt. 4 No WD – Op. Guide	Difference
173rd St	741.73	741.62	-0.10	741.84	0.11	741.51	-0.21
Channel Lake	741.72	741.61	-0.11	741.83	0.11	741.49	-0.22
Fox Lake	741.58	741.47	-0.11	741.69	0.11	741.34	-0.23
Nippersink Creek	742.40	742.33	-0.07	742.48	0.08	742.35	-0.05
Nippersink Lake	741.57	741.46	-0.11	741.68	0.11	741.34	-0.23
Johnsburg	740.96	740.86	-0.10	741.06	0.10	740.62	-0.34
Route 120	740.38	740.29	-0.09	740.47	0.09	739.88	-0.50
US Stratton Dam	739.78	739.70	-0.07	739.86	0.08	739.02	-0.75
DS Stratton Dam	738.16	738.02	-0.14	738.32	0.15	738.38	0.22
Route 176	737.48	737.33	-0.14	737.64	0.16	737.71	0.24
Rawson Bridge	736.86	736.72	-0.15	737.03	0.17	737.12	0.25
Route 14	735.62	735.49	-0.14	735.78	0.16	735.87	0.25
US Algonquin Dam	734.06	733.95	-0.11	734.18	0.13	734.26	0.20
DS Algonquin Dam	733.21	733.06	-0.16	733.38	0.17	733.48	0.26
US Carpentersville Dam	723.98	723.91	-0.06	724.05	0.07	724.10	0.12
DS Carpentersville Dam	719.73	719.58	-0.15	719.90	0.17	720.00	0.27
Main St	717.50	717.36	-0.15	717.67	0.16	717.77	0.26
Richardson Subdivision	714.63	714.50	-0.13	714.77	0.15	714.87	0.25
NW Tollway	713.25	713.12	-0.13	713.40	0.15	713.52	0.27
South Elgin	702.68	702.46	-0.22	702.96	0.27	703.20	0.52

March 1974 Flood Event

The March 1974 flood event was a spring thaw event. The peak flow measured at the Algonquin gage was 5310 cfs. Above normal precipitation in the first two months of the year created periods of above normal flow and high soil moisture content in the watershed. In early March above normal temperatures for several days caused the ground to thaw and released the soil moisture creating increased stages and some flooding.

Alternative 1 - Increased Winter Drawdown

At the beginning of February the historic stage at Fox Lake was above normal pool due to the precipitation. The gates at Stratton were set at 2.78 feet, discharging 1800 cfs in an attempt to lower the pool level. As flows increased in late February and early March, opening the gates wider in the simulation did not increase the drawdown. In the simulation the sluice gates reached the total open position but the Fox Lake stage continued to rise. Achieving a 2 feet drawdown was not possible within the time frame of this previously modeled storm; if the beginning of this storm were moved back in the simulation a month or so it might have been possible to analyze the impacts of a 2 foot winter drawdown.

Alternative 2 – Gates Wide Open

Because of the short time period of the simulated storm the impacts of keeping the gates wide open for the entire winter drawdown period could not be analyzed.

Alternatives 3 and 4 - Eliminating winter drawdown

Alternative 3 increased peak stages 0.01 to 0.03 feet along the entire study area. Alternative 4 reduced stages in the lakes 0.06 feet and in the river upstream of Stratton Dam 0.13 to 0.38 feet. Downstream of Stratton Dam stages were increased an average 0.15 feet. The reduction in lake and river stages upstream of Stratton Dam in Alternative 4 is due to the different gates operations between the historic sequence of gate operations and the gate operations that would result from following the directives of the Operation Plan. During the actual flood event in 1974 the sluice gates were opened to 3.82 feet. However, the simulation of Alternative 4, which is to follow the directives of the Operation Plan, resulted in the sluice gates being completely open (out of the water) allowing more discharge at a lower headwater. The stages upstream of the dam would be lower reducing damages in the lakes, but stages downstream would be higher leading to more damages downstream.

Damage Analysis

This flood event does not evaluate the full benefits of winter drawdown because the historical stage of Fox Lake before the event started was 3.4 feet, 1 foot higher than normal winter drawdown stage. For the 1974 spring thaw event, eliminating the attempted winter drawdown would have resulted in minor increase in stages throughout the region. Using the operation plan, Alternative 4, would result in a small decrease in stage on the Chain of Lakes and a small increase in stage on the Fox River downstream of Stratton Dam.

Table 12 lists the number of flooded structures for the without winter drawdown alternatives. While the stage increase was minor, there were 2 additional structures with

first floor flooding and 30 structures with flood impacts by eliminating the attempted winter drawdown. The pro-active use of the gates along with the loss of winter drawdown increases flood damages to structures located downstream of Stratton Dam. Figures 14-16 are stage hydrographs for Fox Lake, Stratton Tailwater, and Richardson Subdivision. Table 13 lists computed stages and the comparison to the historic operations for locations along the Fox River.

Table 12 – 1974 Flood Damages

	Normal Operations	Alt. 3 No WD – Normal Op.	Additional Structures w/ flooding	Alt. 4 No WD – Op. Guide	Structures w/ flooding eliminated
Structures with water above the first floor elevation					
Above Stratton Dam	16	17	1	15	1
Below Stratton Dam	7	8	1	13	6
Structure with water within 3' of the first floor elevation					
Above Stratton Dam	593	620	27	551	42
Below Stratton Dam	325	328	3	362	37

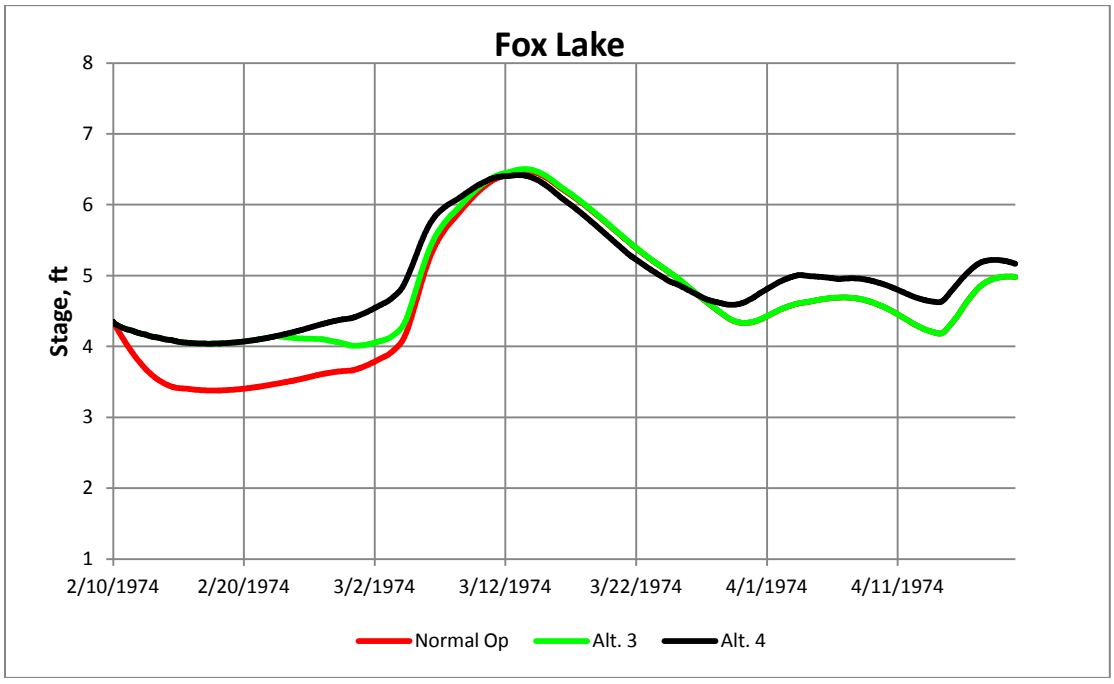

Figure 14 - 1974 - Drawdown Comparison at Fox Lake

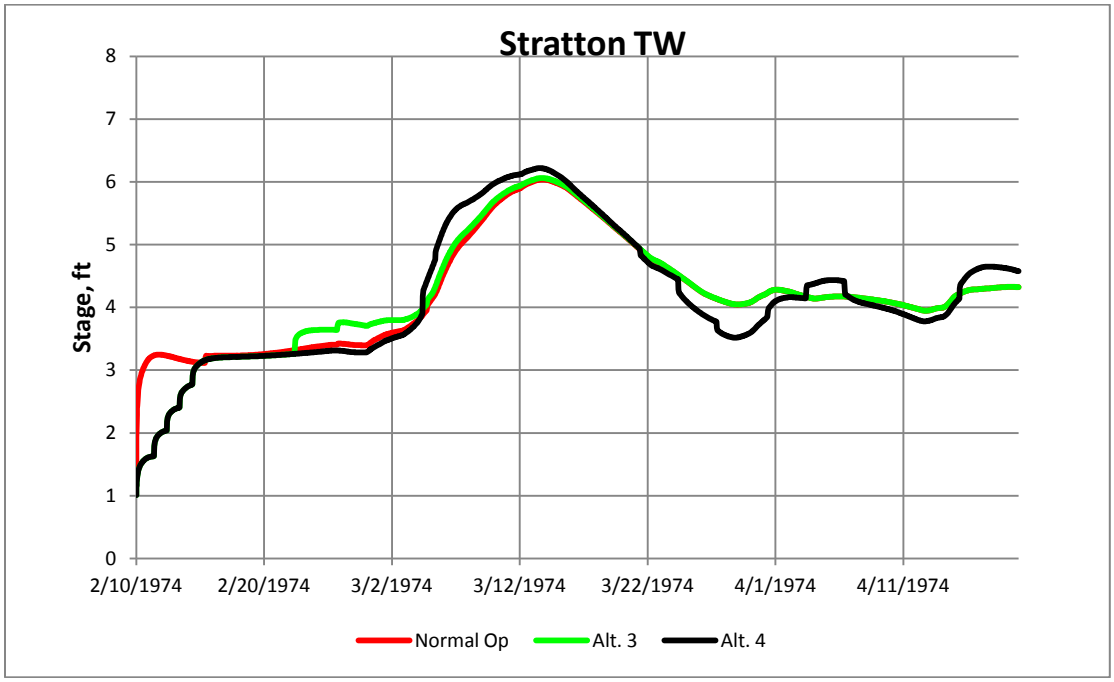

Figure 15 - 1974 - Drawdown Comparison at Stratton Tailwater

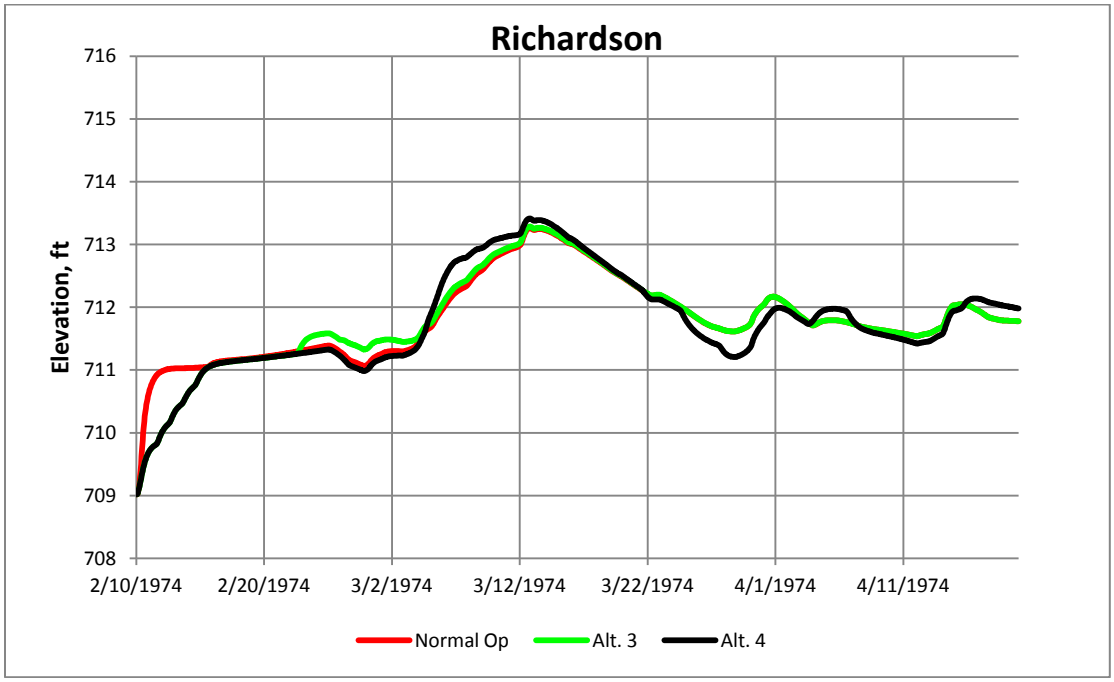

Figure 16 - 1974 - Drawdown Comparison at Richardson Subdivision

Table 13 – Peak Water Surface Comparison March 1974

Location	Computed Water Surface Elevation 3/13/1974				
	Normal Operations	Alt. 3 No WD – Normal Op.	Difference	Alt. 4 No WD – Op. Guide	Difference
173rd St	739.97	739.99	0.02	739.97	0.00
Channel Lake	739.51	739.54	0.03	739.46	-0.05
Fox Lake	739.48	739.50	0.02	739.42	-0.06
Nippersink Lake	739.47	739.50	0.03	739.41	-0.06
Johnsburg	739.01	739.04	0.03	738.88	-0.13
Route 120	738.52	738.55	0.03	738.29	-0.23
US Stratton Dam	738.01	738.04	0.03	737.63	-0.38
DS Stratton Dam	736.19	736.21	0.02	736.37	0.18
Route 176	735.55	735.57	0.02	735.72	0.17
Rawson Bridge	734.99	735.01	0.02	735.15	0.16
Route 14	733.98	734.00	0.02	734.12	0.14
US Algonquin Dam	732.95	732.96	0.01	733.04	0.09
DS Algonquin Dam	731.17	731.19	0.02	731.36	0.19
US Carpentersville Dam	723.20	723.21	0.01	723.27	0.07
DS Carpentersville Dam	717.93	717.95	0.02	718.10	0.17
Main St	715.73	715.76	0.03	715.91	0.18
Richardson Subdivision	713.26	713.29	0.03	713.42	0.16
NW Tollway	712.08	712.10	0.02	712.21	0.13
South Elgin	702.13	702.14	0.01	702.18	0.05

February – March 1979 Flood Event

The spring flood of 1979 was considered one of the top two floods of record for the Fox River when the ISWS report was published. The peak flow measured at the Algonquin gage was 6610 cfs. Flooding resulted from snowmelt and minor rainfall. At the time when peak stages were occurring an additional inch of rain fell causing a second peak equal to the first one.

Alternative 1 - Increased Winter Drawdown

For this alternative, the original drawdown rate in the middle of February was increased in the simulation to try to reach a pool level of 2 feet before the storm event occurred. A drawdown rate of 0.1 feet/day was the target. Historically, the drawdown was only 0.5 feet with a Fox Lake stage of 3.5 feet. For Alternative 1 the pool level was reduced approximately 1.25 feet, a Fox Lake stage of 2.75 feet. A Fox Lake stage of 2.0 feet might have been achieved by increasing the drawdown rate, but drawing the lakes down too quickly, especially during the winter, can cause shoreline damage and hanging ice. Therefore the 0.1 feet/day target was maintained. Alternative 1 lowered the peak stages along the entire river reach approximately 0.01 to 0.03 feet.

Alternative 2 – Gates Wide Open

Because of the short time period of the simulated storm the impacts of keeping the gates wide open for the entire winter drawdown period could not be analyzed.

Alternatives 3 and 4 - Eliminating winter drawdown

Alternative 3, the elimination of winter drawdown, had a minimal impact on peak stages along the entire study area since the drawdown was not achieved historically. Peak stages were reduced approximately 0.01 to 0.03 feet. These results are similar to those computed in Alternative 1. Alternative 4, no winter drawdown with pro-active use of gates, reduced stages approximately 0.3 feet in the lakes and up to 0.64 feet at the Dam. Downstream of the dam stages were reduced an average 0.03 feet.

Damage Analysis

Based on the current listing of homes along the Fox River, almost 2200 structures would be impacted by flooding and 168 of those structures would have flood waters on their living space. Table 14 lists the number of flooded structures for each alternative. Figures 17-19 are stage hydrographs for Fox Lake, Stratton Tailwater and Richardson Subdivision. Table 15 lists computed stages and the comparison to the historic operations for locations along the Fox River.

Increasing or eliminating winter drawdown does not have much effect on peak stages for this storm event. At the beginning of the event in late February and early March, flows were slowly increasing and raising stages in the lakes. By mid March, when the main portion of the storm event occurred, the lake and river elevations were similar for historic operations, Alt.1 and Alt. 3. Therefore, the benefits derived from winter drawdown were negligible. Operating the sluice gates according to the current operations guide provided the most benefits because the sluice gates were opened wider and for a longer time. During the actual flood event the sluice gates were opened to 4.0 feet March 29-April 17,

and 3.5 feet April 27-May 13. Following the operations manual, the gates would have been open wide (out of the water) from March 20-April 18 and April 27-May 9 allowing more discharge at a lower headwater. Therefore the stages upstream of the dam would be lower reducing damages in the lakes and upper river.

Table 14 – 1979 Flood Damages

	Normal Operations	Alt. 1 2' Winter Drawdown	Structures w/ flooding eliminated	Alt. 3 No WD – Normal Op.	Structures w/ flooding eliminated	Alt. 4 No WD – Op. Guide	Structures w/ flooding eliminated
Structures with water above the first floor elevation							
Above Stratton Dam	48	48	0	48	0	29	19
Below Stratton Dam	120	120	0	120	0	119	1
Structure with water within 3' of the first floor elevation							
Above Stratton Dam	1503	1499	4	1499	4	1297	206
Below Stratton Dam	687	687	0	687	0	686	1

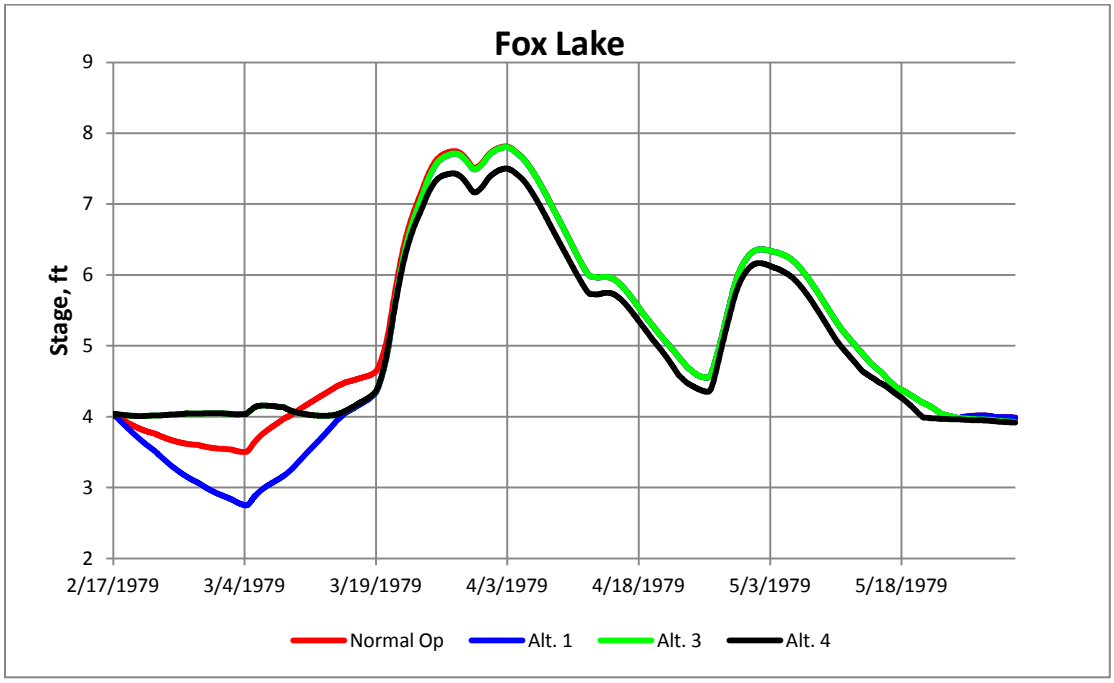

Figure 17 - 1979 - Drawdown Comparison at Fox Lake

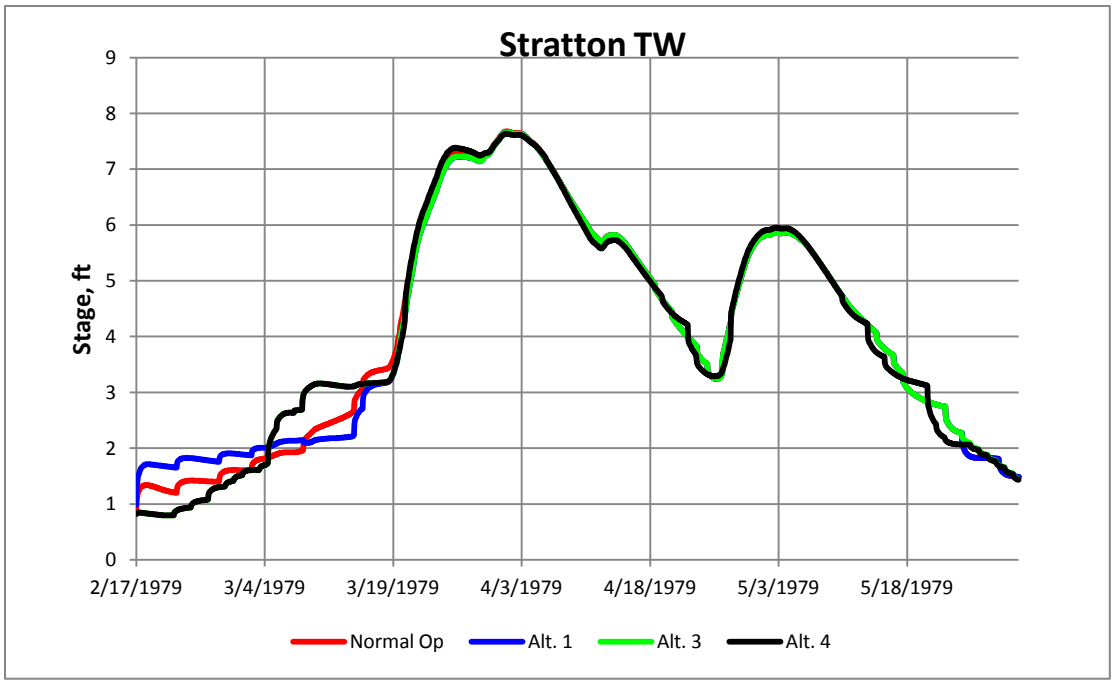

Figure 18 - 1979 - Drawdown Comparison at Stratton Tailwater

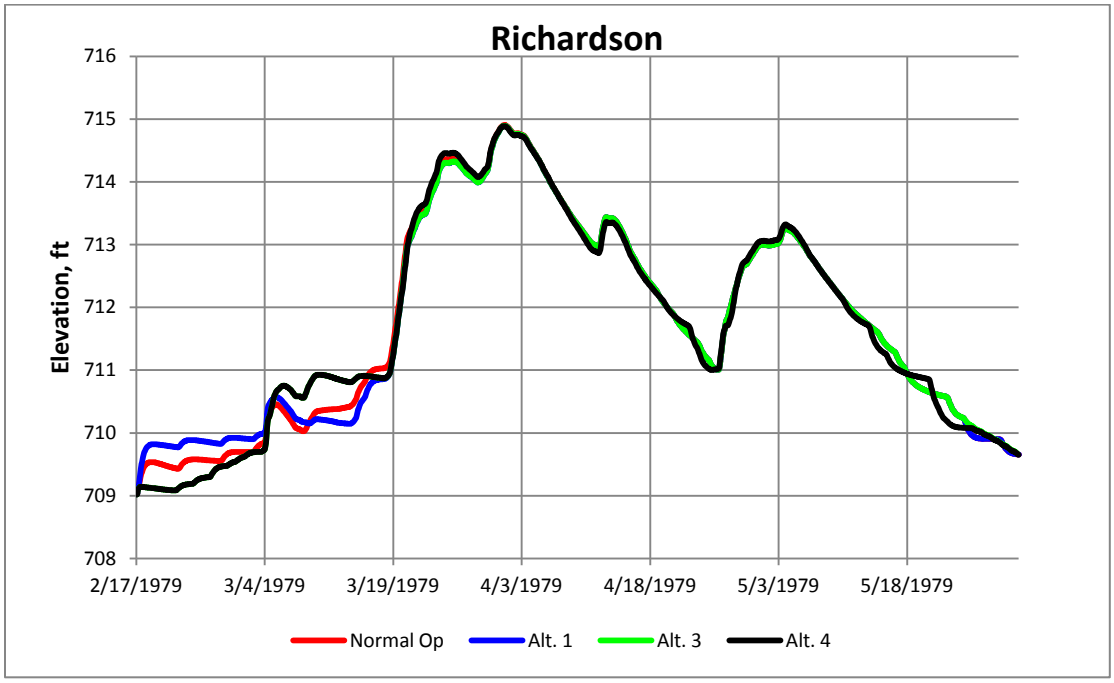

Figure 19 - 1979 - Drawdown Comparison at Richardson Subdivision

Table 15 – Peak Water Surface Comparison April 1979

Location	Computed Water Surface Elevation 4/3/1979						
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No WD – Normal Op.	Difference	Alt. 4 No WD – Op. Guide	Difference
173rd St	741.00	740.99	-0.01	740.99	-0.01	740.78	-0.22
Channel Lake	740.90	740.88	-0.01	740.89	-0.01	740.57	-0.33
Fox Lake	740.81	740.81	-0.01	740.81	-0.01	740.50	-0.31
Nippersink Lake	740.81	740.80	-0.01	740.80	-0.01	740.50	-0.31
Johnsburg	740.26	740.25	-0.01	740.26	-0.01	739.89	-0.38
Route 120	739.71	739.70	-0.01	739.70	-0.01	739.22	-0.48
US Stratton Dam	739.11	739.11	-0.01	739.11	-0.01	738.48	-0.64
DS Stratton Dam	737.83	737.81	-0.02	737.81	-0.01	737.79	-0.04
Route 176	737.26	737.24	-0.02	737.24	-0.01	737.22	-0.04
Rawson Bridge	736.74	736.73	-0.02	736.73	-0.02	736.71	-0.03
Route 14	735.63	735.61	-0.02	735.62	-0.01	735.60	-0.03
US Algonquin Dam	734.11	734.09	-0.01	734.09	-0.01	734.08	-0.02
DS Algonquin Dam	733.33	733.31	-0.02	733.31	-0.02	733.30	-0.02
US Carpentersville Dam	724.06	724.06	-0.01	724.06	-0.01	724.05	-0.01
DS Carpentersville Dam	719.94	719.92	-0.02	719.92	-0.01	719.91	-0.02
Main St	717.72	717.71	-0.01	717.71	-0.01	717.70	-0.02
Richardson Subdivision	714.91	714.89	-0.01	714.89	-0.01	714.89	-0.02
NW Tollway	713.61	713.60	-0.01	713.60	-0.01	713.60	-0.02
South Elgin	703.41	703.40	-0.01	703.40	-0.01	703.40	-0.01

March 1982 Flood Event

According to the ISWS report, 1982 represented an average year flood for the Fox River. The peak flow measured at the Algonquin gage was 4040 cfs. The hinged crest gates were not constructed by 1982 so they are not utilized in the hydraulic modeling.

Alternative 1 - Increased Winter Drawdown

For this alternative, the original drawdown rate in the middle of February was increased in the simulation to try to reach a pool level of 2 feet. A drawdown rate of 0.1 feet/ day was the target. By March 8, a drawdown of 2.0 feet was achieved in the simulation and maintained until the beginning of the flood event in mid March. Historic conditions had Fox Lake drawdown to a river stage of 3.0 feet. Alternative 1 lowered the peak stages along the entire river reach approximately 0.08 to 0.27 feet.

Alternative 2 – Gates Wide Open

Because of the short time period of the simulated storm the impacts of keeping the gates wide open for the entire winter drawdown period could not be analyzed.

Alternative 3 and 4 - Eliminating Winter Drawdown

Alternative 3, eliminating winter drawdown, increased peak stages 0.13 feet in the lakes and approximately 0.1 to 0.2 feet along the entire river. Alternative 4, eliminating winter drawdown while utilizing the pro-active operation plan, did not have much effect on peak stages in the lakes. They were increased 0.01 feet. Peak stages were reduced in the river reach upstream of Stratton Dam 0.03 feet to 0.21 feet. Downstream of the dam stages were increased approximately 0.08 to 0.28 feet.

Damage Analysis

Increasing winter drawdown does reduce stages for the “average flood”, up to 0.15 feet in the lakes and along the river. Increasing winter drawdown would have eliminated flooding impacts on 25 structures which would be a benefit. Eliminating winter drawdown would have a negative impact since it would increase stages and increases the number of structures that are impacted by flooding by 93 structures.

Table 16 lists the number of flooded structures for each alternative. Figures 20-22 are stage hydrographs for Fox Lake, Stratton Tailwater, and Richardson Subdivision. Table 17 lists computed stages and the comparison to the historic operations for locations along the Fox River.

Table 17 – 1982 Flood Damages

	Normal Operations	Alt. 1 2' Winter Drawdown	Structures w/ flooding eliminated	Alt. 3 No WD – Normal Op.	Additional Structures w/ flooding	Alt. 4 No WD – Op. Guide	Additional Structures w/ flooding
Structures with water above the first floor elevation							
Above Stratton Dam	14	14	0	14	0	14	0
Below Stratton Dam	1	1	0	2	1	3	2
Structures with water within 3' of the first floor elevation							
Above Stratton Dam	287	268	19	343	56	284	3
Below Stratton Dam	254	248	6	291	37	295	41

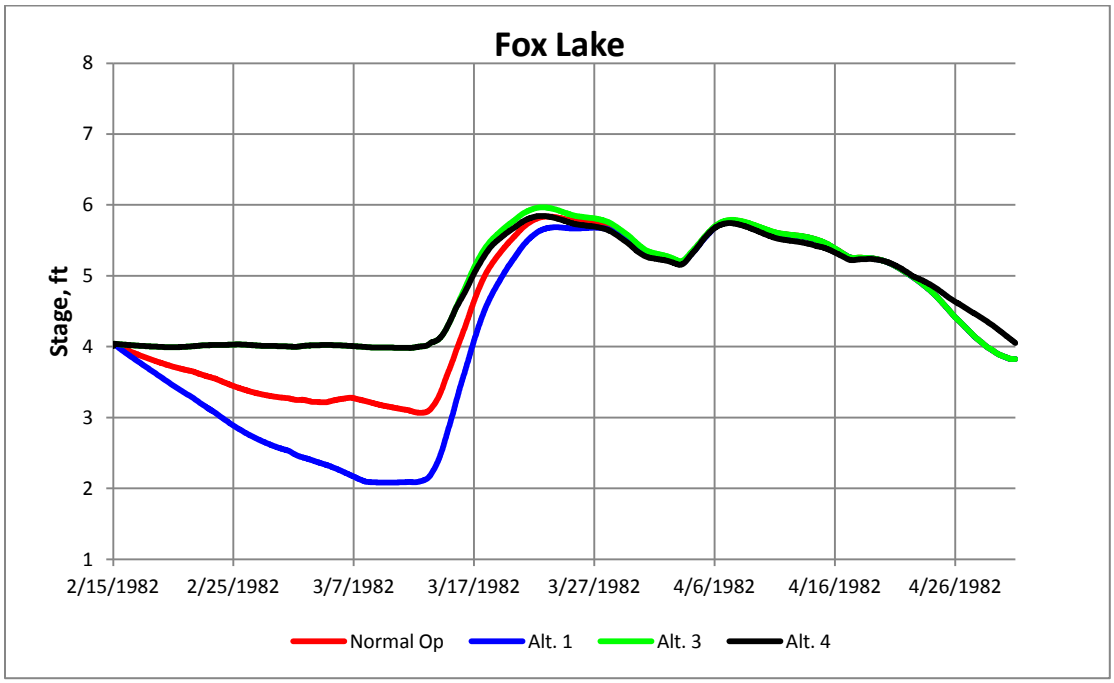

Figure 20 - 1982 - Drawdown Comparison at Fox Lake

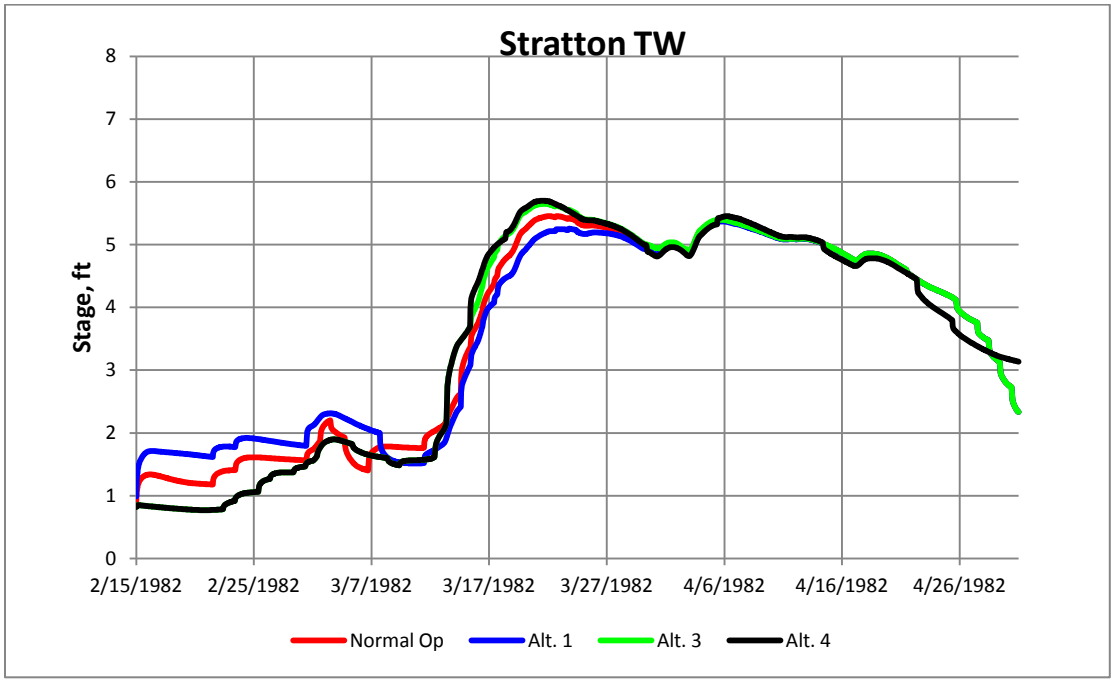

Figure 21 - 1982 - Drawdown Comparison at Stratton Tailwater

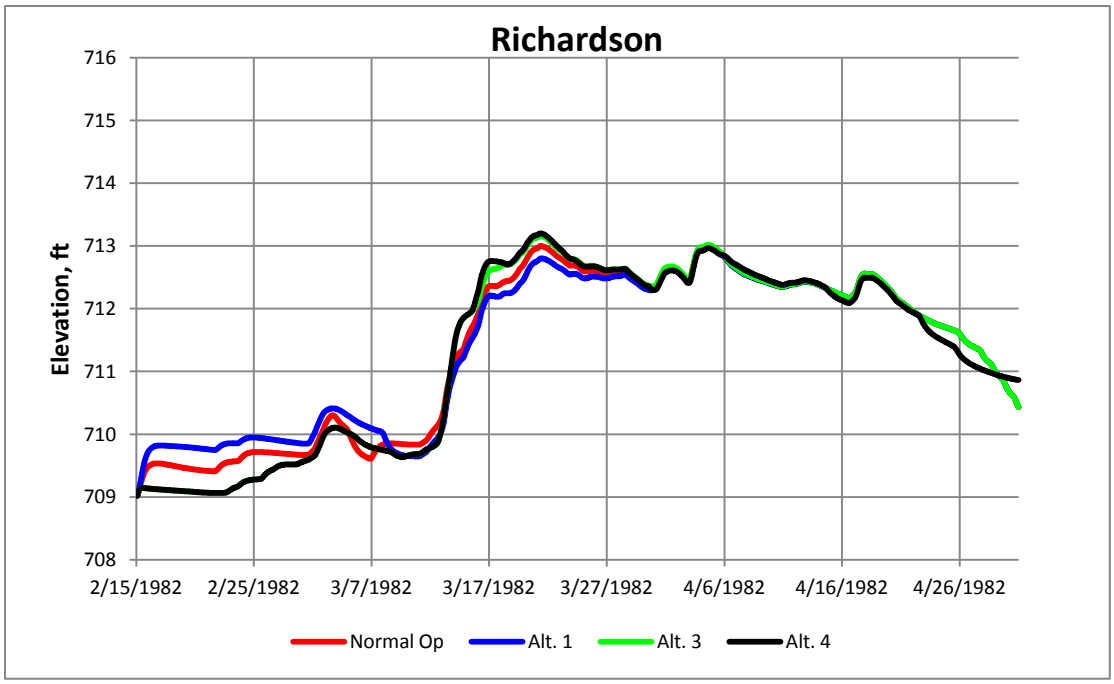

Figure 22 - 1982 - Drawdown Comparison at Richardson Subdivision

Table 18 – Peak Water Surface Comparison March 1982

Location	Computed Water Surface Elevation 3/21/1982						
	Normal Operations	Alt. 1 2' Winter Drawdown	Difference	Alt. 3 No WD – Normal Op.	Difference	Alt. 4 No WD – Op. Guide	Difference
173rd St	739.31	739.24	-0.08	739.42	0.11	739.35	0.04
Channel Lake	738.87	738.72	-0.15	739.00	0.13	738.88	0.01
Fox Lake	738.84	738.69	-0.15	738.97	0.13	738.85	0.01
Nippersink Lake	738.83	738.68	-0.15	738.96	0.13	738.84	0.01
Johnsburg	738.42	738.27	-0.15	738.55	0.13	738.39	-0.03
Route 120	737.96	737.81	-0.15	738.08	0.11	737.86	-0.11
US Stratton Dam	737.50	737.37	-0.13	737.60	0.10	737.29	-0.21
DS Stratton Dam	735.61	735.41	-0.20	735.80	0.19	735.85	0.24
Route 176	735.04	734.81	-0.23	735.23	0.20	735.28	0.25
Rawson Bridge	734.56	734.34	-0.22	734.75	0.19	734.79	0.24
Route 14	733.69	733.50	-0.19	733.84	0.16	733.88	0.20
US Algonquin Dam	732.78	732.66	-0.12	732.87	0.10	732.90	0.12
DS Algonquin Dam	730.81	730.53	-0.27	731.03	0.23	731.08	0.28
US Carpentersville Dam	723.05	722.95	-0.11	723.15	0.09	723.17	0.11
DS Carpentersville Dam	717.62	717.39	-0.24	717.82	0.20	717.87	0.25
Main St	715.41	715.16	-0.25	715.62	0.21	715.67	0.26
Richardson Subdivision	713.00	712.80	-0.20	713.16	0.16	713.20	0.20
NW Tollway	711.81	711.64	-0.17	711.95	0.15	711.99	0.18
South Elgin	701.98	701.90	-0.08	702.04	0.06	702.06	0.08

Delay or Compress Winter Drawdown

Over the years requests have been received to delay or compress winter drawdown, starting either November 15 or December 1. The requests have been prompted by increased recreational benefits of keeping the pool elevation at summer pool throughout the fall and early winter.

Potential impacts of altering the current winter drawdown:

- An early December cold spell could inhibit the winter pool stage from being reached due to the need to reduce flows to prevent ice jam flooding instead of increasing flows to lower the pool stage.
- Typically winter drawdown is completed over 1 month. The slow drop in the water surface elevation allows the banks to drain slowly; thereby reducing bank erosion. Delaying winter drawdown would require a more rapid drawdown in order to reach winter pool stage before a period of significant cold weather occurs .
- If an ice cover would form on the Chain of Lakes before winter drawdown was completed, damage could occur to docks, seawalls, and river banks as the ice is lowered or a void could form between ice and water endangering ice fisherman and snowmobilers.

In order to completed winter drawdown, 12,640 acre-feet of water must be drained from the Chain of Lakes. When completed over the month of November, 200 cfs must be release in addition to the inflows. If the drawdown was attempted over a 2 week period, 420 cfs would need to be released in addition to the inflows. When the drawdown flows are added to the average flow(1) of 800 cfs, the outflows from Stratton Dam would need to be at 1240 cfs to complete drawdown in 2 weeks.[1] When 60° freezing days have accumulated, the outflows from Stratton Dam should be reduced to 1100 cfs.

A hydraulic analysis was not completed to review the impacts of delaying winter drawdown. The analysis for impacts of this request looks at the average temperature and first snowfall in month of December for the last 10 years and this data is shown in Table 19. Of the last 10 years, 60 degree freezing days was reached within the first week of December for 6 of the 10 years and by December 9 for 2 other years. In 9 of the 10 years, snowfall occurred in the first week as week.

The early December cold temperatures that have occurred in the last decade would prevent the completion of winter drawdown if the start of drawdown was delayed until December 1. In 2007 the winter drawdown timeframe was extended to 6 weeks at the request from Fox Waterway Agency because of the unseasonably warm temperatures.

[1] The average flow is based on the gage record for Nippersink Creek near Spring Grove (45 years of record) and the Fox River near New Munster, Wisconsin (17 years of record).

With the below freezing temperatures in early December, the winter drawdown stage was not reached.

Table 19 - Climatogical Data for December 2000- 2010

Year	Date for 60° Freezing Days	First Snow	Amount in inches
2000	12/8/00	12/1/00	1.1
2001	12/27/01	12/24/02	0.6
2002	12/5/02	12/3/02	1.7
2003	Did not occur	12/11/03	0.25
2004	12/20/04	12/1/04	4.8
2005	12/5/05	12/1/05	0.8
2006	12/4/06	12/1/06	8.5
2007	12/6/07	12/5/07	6.5
2008	12/6/08	12/1/08	1.3
2009	12/9/09	12/4/09	1.3
2010	12/7/10	12/6/10	2

Summary

Two winter storm periods (November 1 through March 31) and 4 historic storms were modeled in FEQ to determine the hydraulic benefits of the winter drawdown. These storm periods and events were used to determine the impacts of the alternative operating plans:

1. Increasing the current drawdown from 1.5 feet to 2.0 feet that occurs between November 1 and December 1 and attempting to return the Chain of Lakes to a 2 foot drawdown after any storm events that occur during the winter period.
2. Opening the sluice gates at Stratton Dam to their maximum settings and leaving them at the maximum opening for the entire winter period.
3. Eliminating the winter drawdown completely but operate the gates as was historically done during that time period.
4. Eliminating the winter drawdown completely but operating the gates as dictated by the Stratton and Algonquin Dams Operation Guide for the single event storms.

Table 20 is a summary of the impacts of the four alternatives on the six storm events (or periods.)

Table 20 – Summary of Alternatives

Storm Event	Peak Discharge at Algonquin Dam (cfs)	Alternative 1 Increase drawdown from 1.5 feet to 2.0 feet	Alternative 2 Set sluice gates to maximum opening for entire winter period	Alternative 3 Eliminate drawdown and operate gates as was historically done in that time period	Alternative 4 Eliminate drawdown and operate gates according to Operation Guide
2005 - 2006	3710	Positive	N/A	Negative	N/A
2007 - 2008	3150	Positive	Positive	Negative	N/A
April 1960	6610	Positive	N/A	Negative	Positive
March 1974	5310	N/A	N/A	Negative	Neutral
March 1979	6610	Negligible	N/A	Negligible	Positive
March 1982	4040	Positive	N/A	Negative	Negative

Winter drawdown does provide benefits to the properties along Fox River and Chain of Lakes. For single event storms like April 1960 and March 1982 the extra storage created does play a role in reducing stages throughout the Fox River region. The March 1979 storm was so large, and secondary rainfall extended the duration, that negligible benefits were shown by winter drawdown. Little drawdown, one half foot, was provided in the March 1974 so the benefits were minimal. For the entire winter period analysis of 2005-2006 and 2007-2008, winter drawdown shows large benefits in reducing water stages.

For the two historical time periods that were examined, increasing winter drawdown in the Fox Chain of Lakes from 1.5 feet to 2.0 feet does reduce stage throughout the region. Flood impacts would be removed from 18 homes if winter drawdown was increased to 2 feet. For the single storm events in April 1960 and March 1982, increase winter drawdown would benefit the region with flooding removed from the living area of 43 structures during the April 1960 event.

The historic single storm events were prior to the development of the operation plan. Numerous studies were completed to develop the operation plan including development of a real-time hydrologic model. Analysis of eliminating winter drawdown with the pro-active use of the gates utilized in the current operation plan showed benefits of the pro-active use of the gates for the structures on the Chain of Lakes. However, by eliminating winter drawdown there could be increased stages on the Fox River downstream of Stratton Dam. This analysis did not include the hinged crest gates which were constructed in 2002.

Reviewing the climatological data for the December for the past 10 years shows that 60 degree freezing days often accumulate in the first week of December. Delaying winter

drawdown until November 15 would require the drawdown be completed in 2 weeks which could lead to increase bank erosion. Delaying winter drawdown until December 1 would virtually eliminate winter drawdown as early December cold temperatures would prevent the winter pool from being reached.

Conclusion

Eliminating winter drawdown by maintaining the summer pool all year round would have a negative impact by increasing peak stages and flood damages throughout the region. Increasing stage reduction of winter drawdown would increase the benefits but the environmental impacts have not been analyzed.

The dates for winter drawdown start, November 1, and completion, December 1, are set in the Stratton and Algonquin Dams Operation Guide. Delaying the completion of winter drawdown would be possible when all the following conditions are met.

1. Inflows to the Chain of Lakes are below normal.
2. Temperatures are forecasted to be above normal.
3. Precipitation is forecasted to be below normal.

It should be noted that winter drawdown has significant positive impacts when it is used to reduce the possibility of ice jam flooding. A detailed analysis of ice jam benefits of winter drawdown and the economic impact to the ecology and environment of the Chain of Lakes were beyond the scope of this study.